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SOME ASPECTS OF BEEF PRODUCTION.

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AT the Newcastle-on-Tyne meeting of the British Association in 1916 Mr K. J. J. Mackenzie and the writer read a joint paper to Section M on "Economy in Beef Production." The conclusions arrived at in this paper were based on a large number of rations collected by Mr Mackenzie, both from his own observation on the University Farm at Cambridge and from successful cattle-owners. These rations were worked out by the writer on the basis of starch equivalents, when it was found that all the rations on which animals were making satisfactory and economical progress conformed to a definite curve relating live-weight to food requirement. It was suggested that this curve not only formed a basis for estimating rations, but offered a convenient method for determining the relation between the amount of fodder consumed and the amount of human food produced by the animal. Very soon after the Newcastle meeting both Mr Mackenzie and the writer became absorbed in war work, with the result that the paper has never been published. In the meantime, the writer, assisted by Mr E. T. Halnan, has accumulated much more information on the subject, and is now in a position to draw conclusions of a more definite and useful character which will form the subject of the present communication.

It has long been known that the food requirements of an animal are not directly proportional to its live-weight, that for instance a steer weighing 14 cwt. does not need twice as much food as a two-year-old weighing 7 cwt. Although direct proportion between live-weight and food requirements does not exist, nevertheless it is obvious that there is some kind of relation, for a large animal certainly requires more food than a small one. Is the relation definite, or is it merely haphazard? That the relation is a definite one was first suggested by Bergmann seventy years ago, and again by Müntz in 1878. Both these investigators pointed out that the food consumed by an animal is transformed in the body with the production of heat; that the heat leaves the body for the most part through the skin; and that the food requirement should therefore be proportional to the body surface. It was not, however, until 1883 that Rubner put this suggestion to the test of experiment, and announced his "surface law" that the food requirement of an animal is proportional to the area of its surface. Rubner's experiments were carried out with dogs varying in size from 7 lbs. to 56 lbs. His conclusions have since been confirmed on a variety of animals, and the "surface law" of food requirements has been shown to apply generally, with a fair approximation to accuracy, even to animals of different species.

In view of this general applicability, it was obviously desirable to find out if the series of rations which we had collected, representing the food consumption under practical and successful conditions of cattle of all sizes, from calves weighing less than 1 cwt. to fattening steers weighing as much as three-quarters of a ton, conformed to the "surface law." In order to arrive at a conclusion on this point it was necessary in the first place to establish a definite relation between the live-weight, which can be easily determined with fair accuracy, and the "surface" which is by no means easy to measure. An investigation of this problem was carried out some time ago at the Missouri Experiment Station, U.S.A., and the writer hopes at some future time further to pursue the subject; but for the present purpose the following general consideration will suffice.

It is well known that, in the case of bodies of similar shape and density, the "surface" is directly proportional to the square of the cube root of the weight. In the case of cattle, the shape is approximately the same for all breeds and ages, and the density also is approximately constant, being in all cases rather lower than the density of water. The area of the surface of an animal will therefore be approximately proportional to the square of the cube root of its live-weight. Again, if the food requirement is proportional to the "surface," it too must be proportional to the square of the cube root of the live-weight. On this hypothesis it is easy to construct a curve which will express the theoretical relation between food requirement and live-weight. The method is as follows:—The great majority of feeding experiments have been carried out on cattle weighing about 9 cwt. or 1000 lb., and a large proportion of the rations which we collected referred to cattle of about this weight. Consequently, we could determine with considerable accuracy the average consumption of food by a 1000 lb. steer, which was found to be 22 lb. of dry matter per day for steers making satisfactory and economical progress. Now, the cube root of 1000 is 10, and the square of this is 100, and this is therefore the figure to which the food requirement is proportional. These figures give the starting point of the curve.

To calculate the food requirement of an animal of 125 lbs. live-weight:—the cube root of 125 is 5, the square of this is 25, and the food requirement should be proportional to this figure. Our starting point is the figure 100, with a food consumption of 22 lb. dry matter. The food requirement for the figure 25 will therefore be 22 ÷ 100 × 25 lb. = 5·5 lb. dry matter. Other points on the curve can be calculated in the same way, choosing, in order to save arithmetic, figures for the live-weight whose cube root can be found by inspection. In this way, the following table was prepared:—

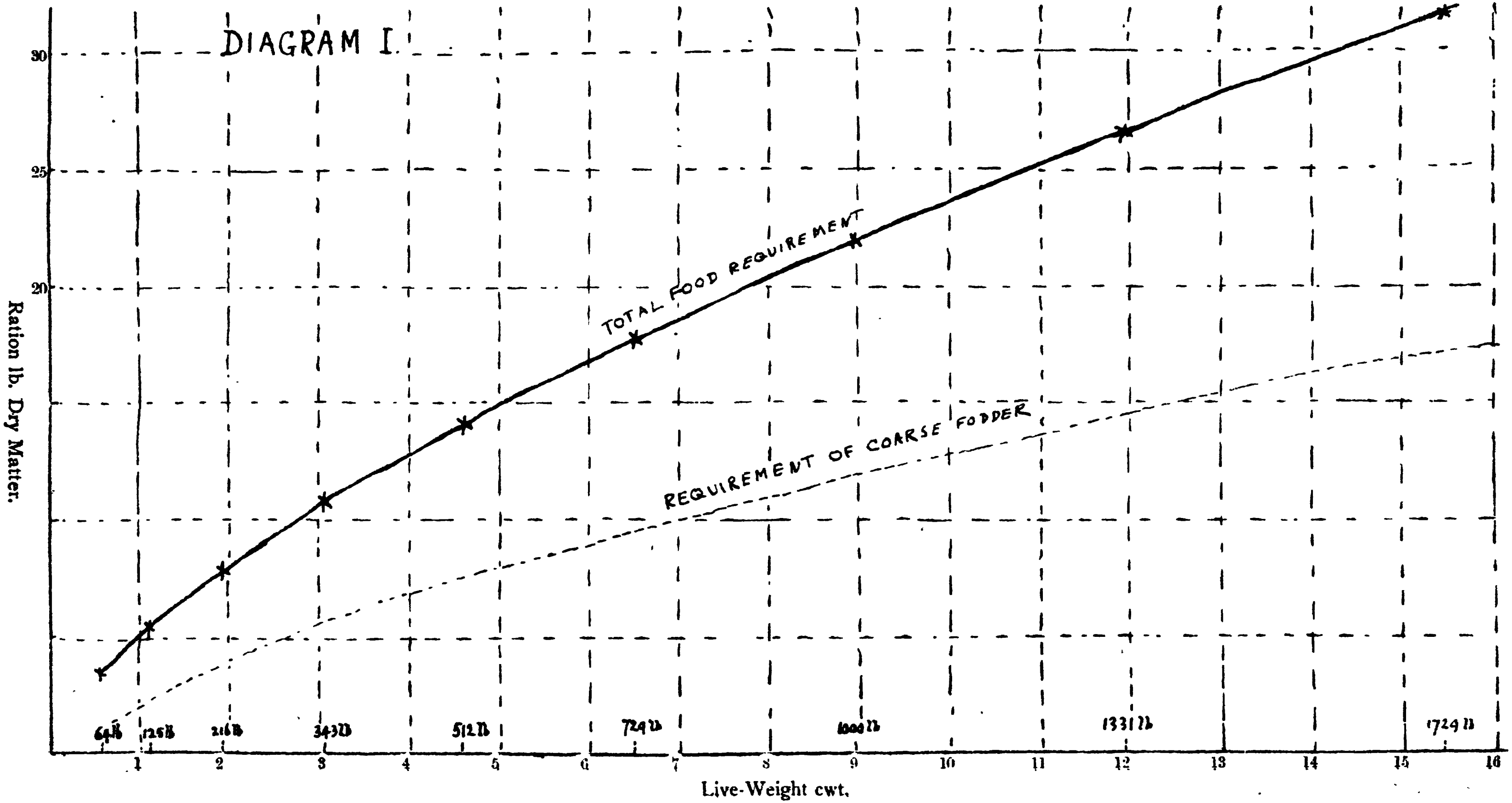
Live-weight lb.	Cube roots of Live-weights.	Square of Cube roots.	Food requirements, lb. dry matter.
1728	12	144	22 ÷ 100 × 144 = 31·6
1331	11	121	22 ÷ 100 × 121 = 26·6
1000	**10**	**100**	**22**
729	9	81	22 ÷ 100 × 81 = 17·8
512	8	64	22 ÷ 100 × 64 = 14·1
343	7	49	22 ÷ 100 × 49 = 10·8
216	6	36	22 ÷ 100 × 36 = 7·9
125	5	25	22 ÷ 100 × 25 = 5·5

The live-weights in the table, although convenient for taking cube roots, are most inconvenient for practical purposes, because they are not readily converted into cwt., the unit commonly employed for expressing live-weights of cattle. The easiest way of removing this difficulty is to plot the figures in the form of a curve as is done in the heavy black curve in Diagram I. (*See following page*).

In this curve, live-weights are recorded in cwt. along the horizontal base line. The live-weights given in the table are then entered on this line in their proper positions. Crosses are placed above these points, opposite the calculated food requirements as given against the vertical line to the left of the diagram. By joining these crosses a curve is obtained which, if the "surface law" holds, gives the relation between live-weight and food requirement. To use the curve, find the live-weight of the animal on the horizontal line. Suppose it is 8 cwt.: follow the vertical line from this point upwards until it cuts the curve, at 20½ lb. dry matter, which is the food requirement of an animal weighing 8 cwt.

Having drawn the theoretical curve in this way, our next step was to calculate the weight of dry matter contained in each of the rations which we had collected, and to insert a cross in the diagram opposite the weight of dry matter, and the live-weight of each case. This was done in a very large number of cases, and it was found that in every case the cross fell so near to the curve as to be within the limits of experimental error. We concluded, therefore that our theoretical curve, constructed according to the "surface law," correctly expressed the relation between the live-weight of an animal and its practical food requirements. In order to express the food requirements of an animal by a single figure, it is, of course, necessary to reduce to one common form the various

DIAGRAM I.


TOTAL FOOD REQUIREMENT
REQUIREMENT OF COARSE FODDER
30
25
20
Ration lb. Dry Matter.
64 lb
125 lb
216 lb
343 lb
512 lb
729 lb
1000 lb
1331 lb
1724 lb
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Live-Weight cwt.

articles which compose the animals diet. We have found it convenient for this purpose to reduce all food to dry matter. For other purposes it is no doubt necessary to adopt some other standard, as for instance starch equivalent, metabolizable energy or calories.

Now, cattle usually get their dry matter in two very distinct forms, namely, coarse fodder of low digestibility, such as hay and straw, and concentrated or succulent fodders of high digestibility, such as cakes, corn, meal and roots. The distinction between these two classes of fodders is a very real and practical one, and its proper recognition is a most useful piece of knowledge. It is that, whilst in the case of coarse fodders about half their nutritive value is transformed into heat in the process of digestion and consequently only the remaining half is available for production of muscular effort, fat, growth or milk, in the case of the more digestible cake, corn, and roots, only one-tenth or less of their nutritive value is converted into heat during digestion, and consequently nine-tenths or more is available for production. We should, therefore, use coarse fodders in sufficient amounts to supply the heat necessary to maintain the body temperature, and the vital functions, but if we wish to produce work, growth, fat or milk, the coarse fodder must be supplemented with cake, corn or roots.

How much coarse fodder will maintain the body temperature and the vital functions? It is known with considerable certainty that 14 lb. of average hay containing 12 lb. of dry matter will suffice for this purpose in the case of a 1000 lb. steer. From this we can calculate a second curve, the lower dotted curve in Diagram I. The two curves in this diagram tell us in terms of dry matter the food requirements of cattle of all weights, both for maintenance and for production.

It is generally accepted that the ration of an animal must contain a certain weight of protein, and this weight will vary according to the live weight of the animal. It is not definitely decided at present, whether the protein requirements are proportional to the live-weight or to the surface. *Prima facie*, one might expect it to be directly proportional to the live-weight, since it is required to make good the loss of protein from the waste of the tissues of the body, but there is no definite experimental confirmation of this view. In the absence of definite experimental evidence, the curve of protein requirements has been constructed empirically from a consideration of the average weight of protein consumed in practice, as calculated from our collection of successful rations. This curve is given in Diagram II.

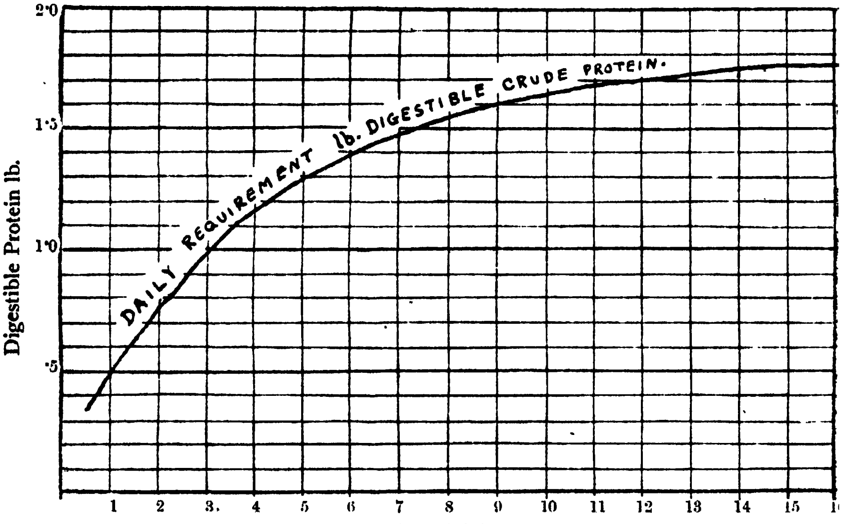
With the aid of these two diagrams, I. and II., it is possible to compound rations for cattle of any size from a knowledge of their live-weight. An example will explain the method.

To compound a ration for a 12 cwt. steer, Diagram I. shows that a 12 cwt. animal requires 14½ lb. of dry matter in the form of coarse fodder for maintenance, and 26 – 14½ lb., or 11½ lb. of dry matter in the form of cake, corn and roots for production of growth and fat. Diagram II. shows that such a steer requires nearly 1·7 lb. of protein. Let us suppose that straw and roots are available in reasonable quantity. Straw contains 86 per cent. of dry matter; 14½ lb. of dry matter will therefore be found in 14½ × 100 ÷ 86 lb. = 17 lb. of straw. Swedes contain 11½ per cent. of dry matter; 11½ lb. of dry matter will therefore be found in 11½ × 100 ÷ 11½ lb. = 100 lb. of Swedes. The following ration would therefore supply the necessary dry matter:—

For maintenance, 14½ lb. dry matter in 17 lb. straw.
For production, 11½ lb. dry matter in 100 lb. Swedes.

This ration should now be checked against the protein requirement curve given in Diagram II., thus:—Oat straw contains 1·0 per cent. of digestible protein, and Swedes 1·1 per cent. The ration will therefore contain:—

DIAGRAM II.



17 lb. straw × 1 ÷ 100 = ·17 lb. digestible protein.
100 lb. swedes × 1·1 ÷ 100 = 1·1 lb. „ „

Total digestible protein in ration 1·27 lb.

This is ·43 lb. below the protein requirement of nearly 1·7 lb. for a 12 cwt. steer. This deficiency must be made good by substituting some kind of concentrated food rich in protein for part of the Swedes. At the present time undecorticated ground nut cake, is one of the cheapest feeding stuffs satisfying this description. This cake contains on the average 27·7 per cent. of digestible protein. To supply the deficiency of ·43 lb. of digestible protein, there will be required ·43 × 100 ÷ 27·7 = 1½ lb. of undecorticated ground nut cake. This will supply very nearly 1½ lb. of dry matter, which must be subtracted from the weight of dry matter required for production, namely 11½ lb. When this is done, 10 lb. of dry matter is left to be supplied by Swedes, and to supply this 10 × 100 ÷ 11½ lb. or 87 lb. of Swedes will be required.

The complete ration will therefore be :—

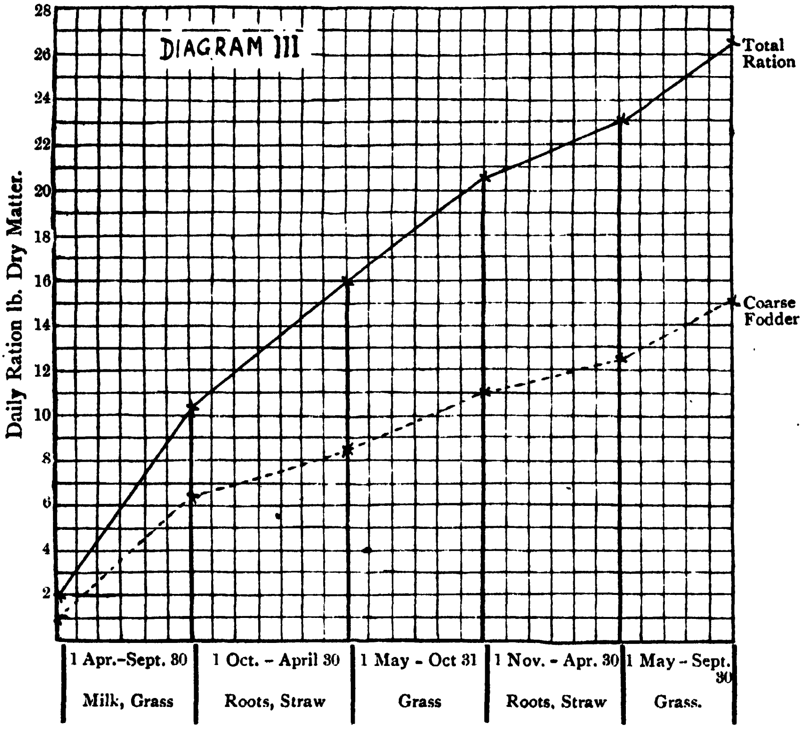
For maintenance	17 lb. oat straw,	containing	14½ lb.	dry matter and	·17 lb.	dig. protein.
For production	87 lb. Swedes	,,	10 lb.	,,	·96 lb.	,,
	1½ lb. cake	,,	1½ lb.	,,	·43 lb.	,,
Total ration, contains therefore			26 lb.	,,	1·56 lb.	,,

This ration satisfies the food requirements of a 12 cwt. steer as given in Diagrams I. and II. within the limits of accuracy, which are possible in the present state of our knowledge. Its slight deficiency in protein is due to the fact that there was a small loss of protein in the 13 lb. of Swedes, for which the cake was substituted, but this deficiency is well within the limits of error which still surround our knowledge of protein requirements.

The above system of compounding rations is simple and easy of application, it avoids all sorts of pitfalls such as nutritive ratios which so frequently entrap even scientific stockowners, and it gives excellent practical results. The writer has used it successfully on his own stock for the last four seasons, and it has also been successfully applied by several large cattle feeders in the eastern counties of England.

An obvious extension of this method of showing the relation between live-weight and food consumption, makes it easy to estimate the amount of fodder required to produce a given amount of human food in the form of beef. Perhaps, it would be more accurate to say, that it would make this problem easy, if we were in possession of accurate figures for the rate of growth of the various breeds of beef cattle in the very varying conditions under which they are raised. On this subject, however, there is practically no systematic information, and our only possible course is to proceed by conjecture. Fortunately the results are so striking that the probable inaccuracy of our conjectures is not sufficient to nullify the general argument. Anyway, if the enquiry serves only to emphasize the necessity of obtaining accurate growth statistics for the various breeds of cattle the writer will be satisfied.

To proceed now with our conjectures. Let us take the case of what the Americans would call an ordinary grade shorthorn calf born early in April. It weighs 90 lb. at birth, and we will suppose that it gets nothing but its mother's milk and grass until the 30th September. During this period of 183 days it may be assumed to increase in live-weight at the rate of 1¾ lb. per day, *i.e.*, from 90 lb. to 410 lb. From 1st October to 30th April let us suppose that its food consists of roots and straw. This diet will be deficient in protein and the animal's growth will not be rapid Suppose it is at the rate of 1 lb. per day. During the period of 212 days it will increase by 212 lb., and its live-weight on 30th April will be 410 + 212 = 622 lb. It will now run out on poor grass-land until 31st October, a period of 184 days during which it may be expected to grow at the rate of 1½ lb. per day if the grass is not very poor, and on 31st October its live-weight will therefore be 898 lb. Let us suppose that it is then wintered from 1st November to 30th April, a period of 181 days, on a diet of roots and straw on which again it grows at the rate of only 1 lb. per day. Its weight will now be 1079 lb., and it will be two years old. It may now be transferred to good grass-land on which it will grow and fatten at the rate of 2 lb. per day, so that on 30th September when it is slaughtered after 153 days on the good grass it will weigh 1079 + 306 or 1385 lb. Such an animal may be expected to yield 60 per cent. of its live-weight as dressed carcase, *i.e.*, 831 lb. of saleable meat.

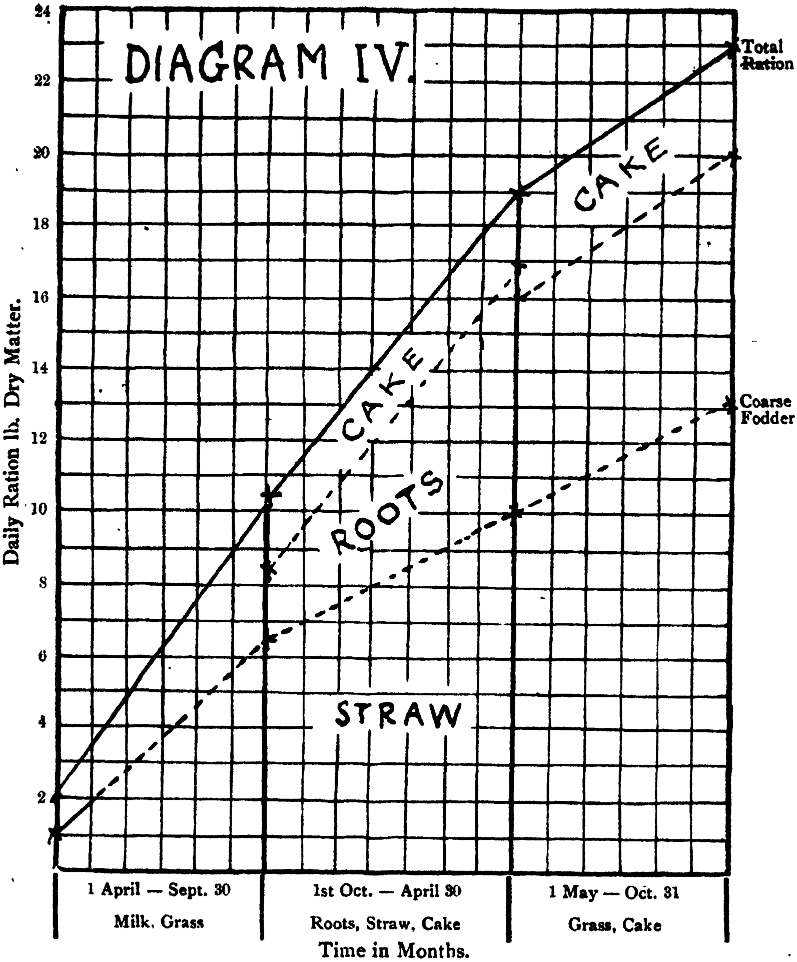


These figures are set out along the base of the annexed diagram—Diagram III. To connect live-weight with food consumption, the procedure is as follows:—for the commencing live-weight of 90 lb. the ration indicated by the curve of Diagram I. is 2 lb. dry matter per day. For the live-weight of 410 lb. at the end of the first grass-feeding period the ration according to the curve is 10½ lb. These rations are marked in the diagram by crosses at points opposite the rations and above the proper dates. The straight line joining these crosses indicates the ration consumed at intermediate dates and weights. The same procedure is followed throughout, and the bent line shown on the diagram is obtained. This line shows the rations consumed during the various stages of the life of the animal, assuming always that during the times when it is at grass it consumes the same weight of dry matter in its self-appointed ration of grass as an animal of similar weight would do if fed upon a mixed ration of hay, straw, roots and cake. There seems no reason to doubt the substantial accuracy of this assumption. It is more likely to be correct than any of the very few attempts which have been made to measure directly an animals grass consumption when at pasture. A small inaccuracy is probably introduced for the first few months by the fact that the dry matter of milk is probably more effective weight for weight than the dry matter of any other feeding stuff. Hence the actual consumption for the first few months is likely to be less than that computed from Diagram I. and entered in Diagram III. The error introduced by this is, however, quite small since the consumption in the first few months is low. From the diagram it is quite easy to compute the total food consumption in terms of dry matter, for since the vertical lines measure the food consumed per day in pounds of dry matter, and the horizontal lines measure the periods during which the food was consumed, the area included between the heavy black-lines must measure the total food consumption in pounds of dry matter. This area can be readily determined by counting the number of squares, and this can be done with sufficient accuracy by counting portions of squares which are greater than half a square as one square, and neglecting portion of squares which are less than half a square.

The number of squares arrived at in this way was is 487. To convert this into pounds of dry matter it must be multiplied by thirty, the average number of days in a month, because whilst the rations are daily rations, the horizontal sides of the squares represent months. The total food consumption is therefore 487 × 30 = 14,610 lb. of dry matter, or nearly 7 tons.

This is the amount of dry matter consumed during its life by a steer slaughtered at thirty months, when it weighed 1385 lb. or 12 cwt. 3 stone live-weight, and might be expected to yield 831 lb. of saleable meat. In this case, therefore, 18 lb. of dry matter were consumed in the production of 1 lb. of saleable meat. Analyses of the carcases of such animals carried out during the last two years in the School of Agriculture by the staff of the Animal Nutrition Institute, make it possible to carry this enquiry one step further. These analyses show that the carcase of such an animal contains 60·7 per cent. of water, bone and waste, and 39·3 per cent. of edible protein and fat.

It appears, therefore, that the carcase weighing 831 lb. contained 327 lb. of real human food in the form of protein and fat. Beef production, as above described, results therefore in the consumption of 46 lb. of the dry produce of the soil in the form of grass, roots and straw for every pound of dry human food produced by the animal in the form of the protein and fat of the dressed carcase. Looked at in this way, such an "extensive" method of producing human food in the form of beef seems to be extremely wasteful of the produce of the soil. Before we can pass such a judgment, however, it is desirable that we should investigate a more "intensive" method. Let us for instance imagine that our six-months-old calf weighing 410 lb. off the grass is liberally fed during his first winter on a ration which includes hay, roots and cake on which he thrives and grows at the rate of 1¾ lb. per day so that by the end of April he weighs 781 lb. Let us further suppose that he is given 3 lb. of cake per day whilst he is out at grass for the next six months during which period he grows and fattens at the rate of 2 lb. per day. This will bring his weight by 31st October to 1149 lb. or 10 cwt. 2 stone. He will now be killed at eighteen months old for "baby beef." He may be expected to yield 57 per cent. of his live-weight as dressed carcase, or 655 lb. of saleable meat.



His food consumption can be estimated as before by constructing an appropriate diagram. This has been done in Diagram IV.

From this diagram the food consumption can be estimated as before. It is found to be 8040 lb. of dry matter. Since the animal was estimated to yield 655 lb. of saleable meat, the consumption of dry matter in the case of this more intensively fed animal is 12¼ lb. of dry matter per pound of saleable meat produced.

The carcase of such an animal when dissected and analysed was found to consist of 65·7 per cent. of water, bone and waste, and 34·3 per cent. of edible protein and fat. The carcase therefore contained 281 lb. of actual dry edible human food in the form of protein and fat. Since it was produced at the expense of 8040 lb. of dry fodder, the fodder consumption in this more intensive method of beef production was 30 lb. of dry fodder per pound of dry edible human food. The more intensive method is therefore much more economical of fodder than the extensive method. The reason is obvious. As long as an animal is alive its vital functions must be maintained and more than half its ration is used up for this purpose alone and does not contribute at all to growth or fattening. Consequently animals will be economical of fodder per pound of flesh produced in proportion to the shortness of their lives.

Though the more intensive method is certainly more economical in food consumption, this does not necessarily imply that it is more economical from the financial point of view. To investigate this latter question it is necessary to analyse the food consumption in the two cases, so that the relative costs of production of beef can be compared. This has been done in the annexed table.

FOOD CONSUMPTION.

	Extensive method lb. Dry matter.	Intensive method lb. Dry matter.
Grass	7770	4400
Straw	3780	...
Roots	3060	900
Hay	...	1760
Cake	...	980
Total	14610	8340

The next step is to estimate the cost of the dry matter of the various foods. Taking swedes at 20/- per ton, straw at 30/- per ton, hay at £5 per ton, cake at £12 per ton, and estimating that the average produce of grass land rented at 30/- per acre is 1 ton of dry matter during the grazing season, the produce of the rest of the year being set off against other expenses, the cost of the various kinds of dry matter works out as follows :—

	Cost of Dry matter per lb.
Swedes	1d
Straw	·186d
Hay	·63d
Cake	1·4d
Grass	·161d

We can now work out the cost of the food consumed in each case. This has been done in the annexed table.

	Extensive			Intensive		
	lb. Dry matter	per lb.	Total Cost	lb. Dry matter	per lb.	Total Cost
		d.	£ s. d.		d.	£ s. d.
Grass	7770	·161	5 4 3	4400	·161	2 19 0
Straw	3780	·186	2 18 7	...	...	...
Roots	3060	1·0	12 15 0	900	1·0	3 15 0
Hay	...	...	...	1760	·63	4 12 3
Cake	...	...	...	980	1·4	5 14 4
			20 17 10			17 0 7
Beef produced lb.			831			655
Cost of Beef per lb.			6·0d			6·2d

From these figures it would appear that there is very little difference in the cost of producing beef, the larger food consumption in the extensive method being balanced by the higher price of the foods which must be used in the intensive method. The costs given exclude everything except food, and even under this head no allowance is made for the cost of the milk consumed by the calf.

I am painfully aware of the many inaccuracies and uncertainties of the above financial computations. On the question of the relative economy of fodder consumption by the intensive method, however, I do not think there is any uncertainty which would invalidate the conclusion that the economy of fodder is greater the younger the animals can be made ready for slaughter. Consequently it follows that if we wish to make more beef in the country, one of our most powerful weapons is to cultivate early maturity. I am aware that much of our grassland is not capable of producing rapid growth, but I am also certain that a wider application of the methods of improving poor pasture worked out by Professors Somerville and Gilchrist and by Sir Thomas Middleton, would go a long way towards the removal of this defect. I do not forget that the intensive production of baby beef is a more strenuous occupation than the slower and more extensive method, and that it is perhaps not so generally possible as is sometimes urged. In spite of all these contentions, the question merits full practical and economic investigation, and I would commend the above method of investigation to agriculturists who desire to add to our present meagre stock of fundamental facts concerning beef production.

THE COST OF TRACTOR AND HORSE LABOUR.

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THE advent of the agricultural tractor and the rapid and general adoption of it by farmers all over the country is certainly the most important, and will prove, probably, to be the most permanent of the innovations due to the recent national emergency. It is of great importance, therefore, to consider the part it can play in connection with the organisation of farm labour and to study the relative cost of farm operations performed by horse and tractor power.

As regards the place of the tractor in the organisation of farm work, it must be remembered that the rise in farm wages makes it of the first importance so to arrange the daily operations in the routine of cultivation, as to make the value of the output of the workers as high as possible. When wages were low it may be that there was no cheaper machine than the manual worker, but in proportion as rates of pay increase so is the necessity intensified for increasing the productivity of labour. The man with a plough and horses has a bigger output at a lower cost than the man with a spade; the man on a tractor has a bigger output than the man with the plough, and if it be established that this output can likewise be secured at a lower unit cost, given certain conditions as to size of farm, size and shape of fields, nature of the land and so forth, then the demands of labour will make it necessary for the farmer to invest the worker to a much greater extent than heretofore with the control of mechanical power. At the present time the tendency of wages is downward, but, whilst opinions may differ as to the ultimate level at which they will become more or less stabilised, any developments which can be proved to tend to increase the efficiency of labour will in the long run have to be adopted generally by the industry.

Thus, it is important to make a study of the conditions under which tractor labour may profitably be substituted for horse labour, and the first thing essential to this end is the collection of data as to relative costs. Cost is not the only factor which has to be considered in connection with the substitution of mechanical for horse power. Just as steam tackle will break up land too hard for the tractor at a time when acts of tillage can be performed with the greatest ultimate benefit, so the tractor can be employed for similar purposes on land too hard for horse power. Not only this, but the farmer equipped with tractor power can start work, for example, upon his stubbles before the horses are released from harvest operations and so, whether it be from pressure of other work, from weather conditions or from other causes, there will be many farms where an equipment which includes an agricultural tractor will result in more efficient cultivation than that which is obtained by horses and horse implements alone. The advantages accruing to the farm from early cultivation or from speedy cultivation in catchy weather, can hardly be measured by any system of accountancy, but whilst these may be very real it is probable that the first consideration in the minds of most farm managers will be the question of relative cost.

Upon this question it is obviously impossible to generalise as conditions vary so much from farm to farm and from district to district, and what is needed is a systematic collection of figures from many farms which might then be interpreted in the light of the attendant circumstances with the object of making some useful comparisons. It may, however, be of interest to record the experience upon one farm where careful records have been kept, partly with the object of showing the results arrived at in a particular case, but chiefly for the purpose of discussing the methods of recording and analysis which are necessary in any case where investigations of this nature are contemplated. The farm in question is situated in the County of Berkshire; it is about 400 acres in extent, and the land changes from a light sand mostly under grass, to a tenacious clay, partly under grass and partly under the plough, and then runs off on a limestone brash entirely under cultivation. About three parts of the whole area are under grass. The tractor used was a Titan bought in 1919 at a cost of £410, whilst the horses worked are of the Shire type.

TRACTOR LABOUR.

It was found that the tractor could be used for any labour on the land usually performed by horses, in addition to doing a good deal of work for which horses are not customarily employed. In the year 1919-20 the following operations were carried out with the aid of the tractor:—ploughing, cultivating, discing, harrowing, rolling, hauling, sawing, hedge-grubbing, running barn machinery. Where implements were used in connection with it, only in the case of the plough was a special tractor implement bought; in all other cases the practice was to join two horse implements together for operation by the tractor. On the experience gained it is not possible to say whether this is a wise course. In this particular case the object was to save piling up a big capital outlay on duplicated implements. Probably one of the greatest temptations which the farmer, who is also an experimenter (as doubtless every farmer should aim at being), has to resist is that of sinking capital in unproductive equipment. On a farm of the size in question it was felt that special tractor implements would be lying idle for so large a part of the year as to make it impossible for them to earn interest on their cost, and the course was adopted of utilising the existing horse implements by coupling them together, even although this sometimes necessitated the purchase of an additional horse implement. The result was not entirely successful, for much time may be wasted in adapting and coupling up horse implements for use behind the tractor, and, moreover, it was found in certain cases that the speed at which the tractor worked relatively to horses imposed too great a strain upon some of the horse implements used. To hazard a forecast it may be suggested that experience will show that where the area of arable land admits of the full utilization of the farm tractor it will be more economical to invest capital in tractor implements, but that where the tractor is kept on comparatively small farms as a stand-by to knock off work quickly at certain seasons of the year, it will be more profitable to utilise such horse implements as can be adapted.

Methods of Recording.—The tractor driver was not employed whole time with his machine. He kept the ordinary time-sheet recording his time and overtime day by day, in hours, according to the various jobs upon which he was engaged. Thus it was possible to analyse his time and to carry to the tractor account such part of it as was spent with the tractor. He received wages, week by week, only slightly above Wages Board rate, but whenever engaged upon tractor work he was paid a bonus, varying with the nature of the operation performed, from 1/- per acre for ploughing, down to 3d. per acre for harrowing and rolling. The analysis of his pay in the tractor account was carried out under the headings of the various operations performed. In addition to keeping a time-sheet the tractor driver was required to keep a record from day to day of materials used and work done by the tractor. The form of record is as shown in Table I. It should be self explanatory; briefly, it provides a statement of the class and amount of work done daily and of the amount of petrol, paraffin and lubricant used daily on each job. It may be remarked that these materials can very easily be recorded with complete accuracy by filling up the petrol, paraffin and oil tanks to the top each morning before starting work; the amount required in each case is the amount of fuel or lubricant used in the previous day; and, of course, care must be taken to note, in addition, any fuel or lubricant added whilst at work during the day in the field.

Analysis of Costs.—The cost of tractor work on any job was analysed under the following heads:—driver's wages and bonus, petrol, paraffin, lubricant, repairs to tractor, repairs to tractor implements and depreciation of implements, depreciation of tractor. Considering these heads, the first four, namely labour, petrol, paraffin and lubricant are charged up to the different classes of work from the record sheets already referred to. With regard to repairs, etc., to tractor and implements, the repairs and depreciation on implements are charged to the particular work performed; thus, repairs and depreciation on plough are allocated to ploughing, repairs and depreciation on saw-bench to sawing, and so on. Repairs to the tractor include not only replacement of parts and any tradesmen's bills for repair of breakages which the skill of the driver was insufficient to remedy, but also the driver's time in taking down any parts as required, and generally in tuning up the machine to keep it running efficiently. In the case under consideration, the driver had had considerable pre-war experience of machinery with a steam ploughing set, and the tractor did not leave the farm once during the first twelve months to go into the shop for repairs. He usually attended at the farm on Sundays to overhaul the engine, and to make any adjustments, so as to leave

TABLE I.

PARTICULARS OF MATERIALS USED AND WORK DONE BY TRACTOR.

	First Day	Second Day	Third Day	Fourth Day	Fifth Day	Sixth Day	Seventh Day	Weekly Summary
Quantity of paraffin in tank ,, added	6 galls. 10 ,,	5 galls. 12 ,,	7 galls. 14 ,,	5 galls. 6 ,,	2 galls. Nil.	Nil. 14 galls.		
Total ,, at end of day	16 ,, 5 ,,	17 ,, 7 ,,	21 ,, 5 ,,	11 ,, 2 ,,	2 galls. Nil.	14 ,, 4 ,,		Materials used :— 58 galls. paraffin 6 pts. petrol 3 galls. 2 pts. lubricating oil
,, of paraffin used	11 ,,	10 ,,	16 ,,	9 ,,	2 galls.	10 ,,		
,, petrol used lubricating oil used	1 pt. 4 pts.	1 pt. 4 pts.	1 pt. 6 pts.	1 pt. 4 pts.	1 pt. 4 pts.	1 pt. 4 pts.		
Particulars of work done :- Nature of work Field or Yard	Ploughing Field 17	Ploughing Field 17	Ploughing Field 17	Ploughing Field 17	Ploughing Field 1	Ploughing Field 1		Work done :— Ploughing— Field 17 - 12 acres Field 1 - 3¾ ,, 15¾ ,,
Quantity of work done (as near as possible) :- Acreage Ploughed, etc. Weight of roots cut, hay chaffed (and kind of) straw chaffed	3 acres	3 acres	4 acres	2 acres	¾ acre	3 acres		

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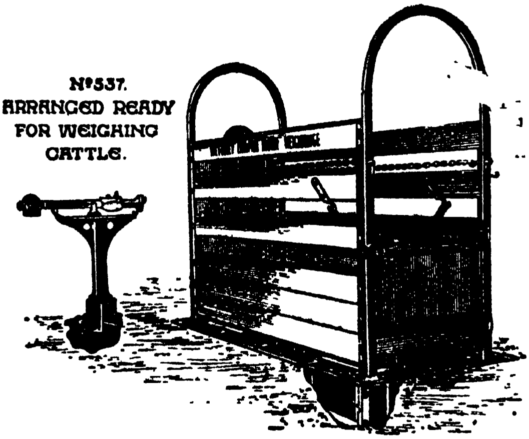

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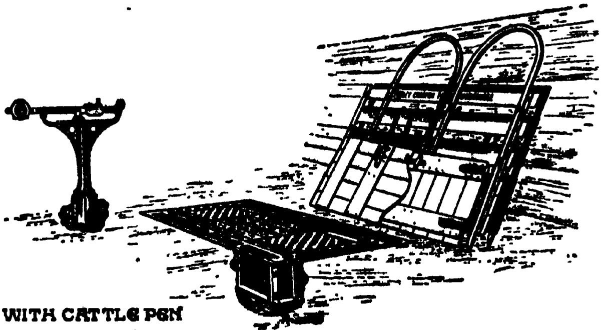

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the week days entirely free for work on the land or elsewhere. Whilst the cost of repairs and depreciation of implements is easily assigned to the various operations, the distribution of the repairs to the tractor itself is a more difficult matter. The destructive effect of work done varies very considerably with the nature of the work; for example, a stationary tractor driving a threshing machine, barn machinery or saw-bench, is obviously less liable to wear and tear or breakdown than one engaged in tractive work of any kind, whether on the land or on the road, and it is necessary to find some basis for distributing the cost of repairs and upkeep which takes account of this fact. After much consideration it was decided that in all probability the fuel consumption might be used as a basis. The load on a tractor pulling a plough may be no more than the load when threshing, but the tractor on the land has to move itself, as well as the plough, with a consequently higher fuel consumption and greater destructive effect; thus the amount of petrol and paraffin used on any job has been taken as the measure of the amount of the tractor repairs bill chargeable against that job.

With regard to the depreciation on the tractor two points have to be considered; first, the life to be assigned to the machine in order to arrive at the total annual depreciation; second, the distribution of the annual depreciation over the various classes of work performed. There is no evidence as to the number of years of effective work in the tractor: obviously it must depend upon the make of the machine, upon the extent to which it is kept regularly employed, and on the skill and attention of the tractor driver. Moreover, it is likely that improvements in construction and, possibly, in the manufacture of new types of machines will render those in use at the present day obsolete in a comparatively short time. It is impossible to balance all these factors and to arrive at any figure which may be said fairly to represent the life of the average tractor, but as the initial cost is so high and as the life, under the best conditions, must be relatively short the question of depreciation cannot be ignored, and in the example under consideration it was decided to give the machine a life of five years and to depreciate it accordingly. As to the allocation of the depreciation to the different operations performed, the basis adopted was that already decided upon in connection with the distribution of the item for repairs and upkeep, namely, the fuel consumption in each case.

Implements and Machines Employed.—Ploughing was done by a three furrow Cockshutt plough operated by the driver. This is a great improvement on types which require the work of a second man to control them. Cultivating, disc harrowing, chain harrowing and rolling were performed in every case by two horse machines working side by side and coupled to a bar attached to the tractor. Chaff cutting, grinding and sawing were carried out by machines constructed for power. Hauling was confined to manure and stone hauling; for this purpose a large sledge capable of holding two tons of stone was constructed on three iron shod runners. It was not possible accurately to record the weights and distances so that no "ton mile" costs could be ascertained; so far as could be estimated the work was cheaply performed when the tractor could be kept at work all day upon the job, but the effect of the sledge on roads and fields was rather severe. Hedge grubbing was done with the aid of a chain and the tractor proved very efficacious on this troublesome work. The hedge in question was very old and overgrown, and probably had not been cut for some thirty years. There was a tendency for the thorns to break off about two feet above the ground, but when this was counteracted by having a man standing by with a mattock to chop through roots whenever the heaving of the ground indicated their position the work was most efficiently performed.

The results of the year's work with the tractor are given in the table on opposite page.

HORSE LABOUR.

Horse labour costs were kept for the same year (1919–1920), and the operations recorded were:—ploughing, cultivating, discing, harrowing, rolling; for other work done by horses there are no tractor figures comparable, and it has, therefore, been omitted.

Methods of Recording.—The horsemen were wholly employed with their horses except when stopped by wet weather. Their work was recorded, in hours, on the same form of time-sheet as used by the tractor driver, thus allowing of an allocation of their time to the different operations performed. Time spent in the stable or on visits to forge, etc., was charged to the horses. A special column on the time-sheet allowed each man to record the number of horses at work with him on the job. The men received a flat weekly rate of pay based on the weekly hours customarily worked, and calculated at Wages Board rates for time and overtime; on top of this they received a cottage each for which no deduction from wages was made, and any hours of work beyond the customary hours were paid for extra. No special record forms other than the time-sheets were used in connection with the horse labour costs.

Analysis of Costs.—The total cost was analysed under the following heads:—Manual Labour, Horse Maintenance, Repairs to Implements and Depreciation. Labour has been dealt with above. As regards horses a ledger account was kept which was charged during the year with all the expenses of maintenance. These include home-grown foods, grazing, purchased foods, veterinary and smithy accounts, stable labour and depreciation. All foods were taken at cost price, whether home-grown or purchased; it is not necessary here to argue the question of cost price *versus* market price as indicating the measure of value of home-grown feeding stuffs; it is sufficient to state that hay, straw, oats, grazing, etc., were charged against the horses at their cost to the farmer, and not at any imaginary figures assumed to represent their market value. Stable labour has been explained above; veterinary and smithy accounts do not call for comment, and the only other item requiring explanation is depreciation. One of the horses worked was aged, but others were young horses, which, under normal conditions in the horse market, might be regarded as appreciating

TABLE II.

ANALYSIS OF TRACTOR COSTS FOR THE YEAR 1919–20.

	Driver's wages and bonus			Petrol			Paraffin			Lubricant			Repairs, etc.			Depreciation			Total			Work Done	Cost			
	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d		£	s	d	
Ploughing	34	16	3½	2	8	4	72	16	0	26	18	9	17	6	9	45	0	0	199	6	1½	95 acres	2	2	0	per acre
Cultivating, etc.	5	12	6½	0	7	7	11	1	0	4	9	8	2	1	2	5	19	11	29	11	10½	73 acres	0	8	1	per acre
Chain-harrowing or Rolling	18	3	1	0	16	10	22	7	6	10	13	2	4	3	4	12	18	0	69	1	11	501 acres	0	2	9	per acre
Disc Harrowing	1	1	11	0	1	10	2	13	0	1	6	5	0	9	10	1	8	9	7	1	9	22 acres	0	6	5	per acre
Chaff-cutting	6	4	6	0	11	6	7	9	1	5	6	8	1	7	10	4	13	11	25	13	6	239 cwt.	0	2	2	per cwt.
Grinding	2	10	2	0	4	5	4	9	0	1	19	9	0	16	7	2	8	3	12	8	2	147 cwt.	0	1	8½	per cwt.
Hedge grubbing	5	8	0	0	9	9	10	0	2	3	12	9	1	17	4	5	8	8	26	16	8	25 chns.	1	1	6	per chn.
Wood sawing	6	1	5	0	10	0	10	19	1	4	18	1	2	0	10	6	4	2	30	13	7	?	0	?		
Hauling	6	6	1½	0	10	11	13	4	4	6	8	2	2	9	3	7	3	6	36	2	3½	?	0	?		
Total	86	4	0½	6	1	2	154	19	2	65	13	5	32	12	11	91	5	2	436	15	10½					
Percentage analysis of total cost	19·74			1·39			35·48			15·03			7·47			20·89			100·00							

in value. Nevertheless, a charge for depreciation was made in every case. Justification for this practice is that the depreciation on a horse, from his cost at maturity for work down to his death, should be borne equally over the whole period of his working life. The advantage accruing to the farmer who works a large proportion of young horses increasing annually in value, or the disadvantage of using mainly aged animals depreciating year by year, must not be applied fictitiously to reduce or to increase the cost of horse labour on the farm. The business of breeding horses, or of dealing in them, is a matter entirely apart from the performance of horse labour on the holding, and the farmer's success or otherwise in either of these capacities must be recorded separately, and must not be allowed to confuse the calculation of horse labour costs. Thus, a charge for depreciation must be made in the case of every horse worked, and the amount of the charge is got by taking the cost of the horse when purchased or, if home bred, when brought into work on the farm, and dividing this figure by the estimated number of years of effective life. For example, the depreciation on a horse bought at four years old for £56, and estimated to work until eighteen years of age (*i.e.*, having fourteen years of effective life before him) is £4 per annum. Depreciation must also be charged against the horses in respect of harness and stable tools. The figure is arrived at in the same way as that for depreciation on horses, namely by taking the cost of the articles concerned and dividing by the number of years of probable life; to this is added any tradesmen's bills for repairs, harness oil, etc.

As regards repairs to implements and depreciation on them the procedure has already been indicated when discussing tractor implements.

Thus, the total cost of horse maintenance is arrived at. From the record of days worked contained in the men's time-sheets, the cost of a horse-day is calculated, and from the record of days worked on particular operations provided by the same form the cost of horse labour on any particular operation is ascertained.

The results of a year's work by horse labour on certain operations are given in Table III.

Considering the results shown in Tables 2 and 3, it is obvious that no useful conclusions as to actual relative costs can be drawn from one example based on a single year's work. Nevertheless, certain facts emerge. It is certain that the most important factor in the cost of work by either form of power is the proportion of days worked to possible working days. The cost of keeping a horse varies little, taking the year through, whether he works 200 days or 250 days, but the cost per day worked will be 25 per cent. less in the latter case. It is sometimes asserted that the tractor has an advantage over the horse in that it costs nothing to keep when it is not at work but this is not literally true, for unless some better method for calculating depreciation on the machine can be suggested than the one adopted here the charge for this item varies inversely with the number of days worked.

In the example given, the charge for depreciation amounts to no less than £82 per annum, or 5/3 per possible working day (312 per annum), and it is impossible to disregard this factor in comparing the cost of keeping horses with that of keeping a tractor. It is true, however, that there is a direct saving of cost in connection with the idle tractor in that no labour need be employed upon it, whereas horses must be fed and tended in any case.

Considering the figures as they stand, and if further experience should confirm them, it is evident that there is little to choose between the two forms of power as regards actual cost of operations performed, and the tractor must seek to justify itself through the indirect advantages accruing to its use. Tractor power enables the farmer to get work done very often at a time when horse power could not cope with it, even though horses are available and the work crying out to be done. Thus, at the present moment the writer is breaking, with the tractor, stubbles which have been baked so hard by the summer's drought as to put the work beyond the power of horse labour. Similarly in busy seasons and during catchy weather, the tractor will frequently complete at the right moment a job which horse labour could hardly have begun. Many men farming strong land know the difficulty, under certain conditions, of spring ploughing; to begin with, the land has been too wet and then it has dried so fast that work has had to be postponed until rain comes again. The tractor in such a case can sometimes step in and complete the ploughing at the right moment in a period of time during which horses would have got through only a small part of it. The same thing applies at harvesting. The Titan tractor referred to in this article was not employed upon harvest work, but in a season like that of 1920, many men must have realised the advantage of

TABLE III.

ANALYSIS OF HORSE LABOUR COSTS FOR THE YEAR 1919-20.

	Wages.	Horse Maintenance.	Implements Depreciation and Repairs.	Total.	Work Done.	Cost.
					acres	per acre
	£ s d	£ s d	£ s d	£ s d		£ s d
Ploughing . .	31 0 11	58 11 11	6 7 2	96 0 0	42	2 5 9
Cultivating . .	3 0 8	5 15 5	0 12 9	9 8 10	31	0 6 1
Harrowing . .	10 5 4	18 6 7	1 19 6	30 11 5	228	0 2 8·1
Rolling . . .	1 3 4½	1 14 4	0 3 6	3 1 2½	18	0 3 4·8
Disc Harrowing	4 16 1½	14 13 4	1 11 5	21 0 10½	81	0 5 2·3
Total . .	50 6 5	99 1 7	10 14 4	160 2 4	...	..
Percentage Analysis of Total Cost	31·42	61·88	6·70	100·00	...	...

working a binder for long days at high speed behind a tractor, thus leaving their horses free for carting and similar work. Any generalisations at this stage of experience of tractor work must be made with reserve, but if it be safe to assert that the tractor will be useful to supplement rather than to supersede horse power, and that the cost of tractor work is not materially less than that of horse work, then also must it be conceded that the ability which the tractor confers upon the farm manager to do work at the right time, and at speed, will result in considerable financial advantage to him even though no method of book-keeping will enable him to make any accurate measure of it.

The writer is indebted to Mr A. Loose for working out the tables of tractor and horse labour costs given here.

THE BIOLOGIST ON THE FARM.—No. V.[1]

PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.,

Lecturer on Agricultural Zoology in the North of Scotland College of Agriculture.

Meeting the Winter.—What the farmer has to give the Biologist is information; what the Biologist has to give the farmer is a scientific clue. Every one knows that a squirrel stores nuts and that a brown stoat turns into a white ermine, but it is not always recognised that the squirrel's store and the stoat's blanching go together, and along with half a dozen other phenomena, as solutions of the problem of winter.

In northern countries, winter means cold and scarcity, stormy weather and frozen ground; and animals have to meet these limitations and difficulties. This is part of their struggle for existence. So we see the Shetland Pony with a shaggier coat and the badger with a store of fat below his skin. In both cases there is a conservation of the precious animal heat, which makes it possible for the chemical processes of the body to go on more quickly and smoothly. Moreover, the fat can be slowly burned away during the hard winter months.

Hamsters store hay, and we read that the Mongolian herdsman brings his cow in autumn to eat the haystacks which are so diligently built in the summer months by the quaint tail-less hares. Some voles store vegetable supplies, and the mole has a larder of decapitated earthworms—a last resource when the frost grips deeply. It is the storing habit that has made it possible for the ants to continue as communities from year to year, and the same is evident in bees. Of the Humble-bees that do not store, only the young queens survive through the winter; of the Hive-bees a large fraction of the population lives on into the next year.

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[1] The previous articles in this series appeared in Vol. III. of this *Journal*, 1920.

The Mountain Hare or Variable Hare turns white, save the black tips of its ears, and the same kind of change is seen in other familiar cases, such as stoat and ptarmigan. It is often exhibited by the Arctic Fox of Scandinavia, which, by the way, is also in the habit of making stores of food in caches beneath the snow. For the most part, the blanching is due to a new growth of hair or feathers, in which the place of pigment is taken by a multitude of gas vacuoles. The whiteness of a Mountain Hare is like that of foam; that is to say, the light is almost perfectly reflected from a multitude of mirror-like surfaces. There can be little doubt that the whiteness is to some extent a useful concealment—a garment of invisibility—against a background of snow; but its deeper significance is almost certainly that for a warm-blooded animal in cold surroundings a white dress is the most economical dress. It conserves the animal heat more effectively than a similar dress of any other colour.

Some animals meet the winter by tightening their belt and living more "dangerously." Thus the packs of wolves intensify the keenness of their hunting, and we are reading just now of the appearance of hungry wolves in parts of Europe where they have been complete strangers for many a year. The otter will swim underneath the ice—a dreadfully dangerous experiment—and we have heard of starving deer swallowing young rabbits, which is against all text-book zoology. What a contrast between quickening the pace and sinking into lethargy! The frog lies in a dried-up drain-pipe; the slow-worms snuggle many-a-bed in the recess of a dry mossy bank; the snail has sealed up its shell in a cranny of the old wall; and how many insects are lying low inside pupa-cases or cocoons. This points the way to the true hibernation of certain mammals like hedgehog and bat, which, being imperfectly warm-blooded, make a strength out of a weakness and survive the winter in confined spaces and sheltered corners. They relapse into a sort of reptilian cold-bloodedness, but it pays; and they emerge in spring none the worse of their long fast, all the better of their long rest. The neatest solution of all is that of the migratory birds, for they conquer the winter by circumventing it, "changing their season in a night," and having two summers in their year. There are other solutions besides those that we have mentioned, but our point here is simply this, that what the Biologist does is to unify all these—as different solutions of the same problem, the problem of meeting the winter. They are different tactics employed against a common enemy. Their parallels with man's methods are interesting.

Leaf-Cutting Ants.—Mr Charles Beebe's fascinating book *The Edge of the Jungle* (Holt, 1921) contains some new information of dramatic interest regarding the Leaf-Cutting Ants (*Atta*) of Guiana. It has long been known that they cut neat segments of leaves from the trees, and transport these to their great underground nest, holding them up like green parasols. On digging into the underground metropolis, a business which required precautions, Mr Beebe had the good fortune to see groups of worker-ants chewing and chewing for dear life. They were making a sort of spongy pabulum on which a certain fungus is grown. This fungus has never been found outside of the Leaf-Cutter's nests, and it affords the entire food-supply indoors. The workers weed off other fungi and they also keep their own particular vanity from fructifying, for what they delight in are drops of liquid that occur at the ends of the fungoid threads, and these cease to be formed if the fungus ceases to be vegetative.

But the keen-sighted explorer discovered something even more striking. When a winged queen leaves the ant-city on a nuptial flight, she takes with her a little pill of the precious fungus, holding it beneath her mouth. When she descends from mid-air, having been fertilised in her flight, she burrows into the ground and begins egg-laying. But she does not lose her pill of fungus; it is carefully treasured for days to come. The queen lays many eggs, and has to eat some of them in order to sustain her energies. Soon, however, some of the eggs hatch out into workers. These eat more surplus eggs, but they are soon able to issue forth and bring in leaves. Then is the time for planting out the fungus, so carefully preserved all this time. Besides the ordinary workers there are soldiers with scythe-like jaws, and peculiar dwarfs or minims who accompany the workers on their expeditions, though unable to cut off leaves. They seem to get woefully tired on the home journey, and three or four may be seen jumping on to a worker ant, and holding firmly to the green parasol. There is a tiny blind cockroach that lives in the nest and gets its food by licking the leaf-sap from the big ants. Mr Beebe tells us that when the queen sails off on her honeymoon, one of the massaging cockroaches sometimes goes with her, all unbeknownst. This is not all, for——, but, perhaps, we have said as much as a sceptical Scots reader will stand at one time.

The Underworld.—After plants had in some measure prepared the way, animals began to invade or colonise the dry land, and it seems reasonable to distinguish three great invasions. There was the worm invasion, which led on to earthworms and consequently to the making of vegetable mould and the great improvement of the soil. Secondly, there was an invasion on the part of air-breathing jointed-footed animals such as centipedes and millipedes, leading on to insects and consequently to the establishment of the most important linkage in the world, that between flowers and their welcome winged visitors. For the cross-pollination of flowers by insects means an improvement not only in the quantity, but also in the quality of the seed. Thirdly, there was the amphibian invasion which we see recapitulated every year when the small frogs migrate from the ponds to the fields. This amphibian invasion led on to the evolution of reptiles, whence sprang both birds and mammals.

But after adventurous pioneers of various races of animals had reached the promised land, they discovered that it was not always flowing with milk and honey. Their movements were restricted to one plane; oxygen was available in larger quantity, but it was less readily captured than in the water; it was much more difficult to secure the safety of the eggs and the young. There were likewise great risks of drought and frost and local overcrowding. So it became necessary for some of the colonists to trek once more, and this is how we should look at the attempts that have been made to get off the surface of the earth—on to trees, into the air, into caves and underneath the ground.

Let us consider for a moment the last adventure. Earthworms probably sprang from a freshwater stock, but they became subterranean and had for a while a golden age in the underworld. But their kingdom was by and by invaded by the pertinacious poisonous centipedes, later on by carnivorous burrowing beetles, much later by moles; so that earthworms are now a much persecuted race. They have had to resort to a very cryptozoic life, adding to their burrowing habits a purely nocturnal above-ground activity.

Until we look into the matter we do not perhaps realise the number and variety of subterranean animals, living like sappers and miners out of sight. There are soil-Amœbæ and soil-Infusorians, sometimes of agricultural importance, for instance by devouring large numbers of the Bacteria which bring about putrefactive and other useful chemical changes underground. There are a few subterranean Planarian worms, and very numerous Threadworms; there are larval insects galore and not a few adults; some snails and slugs burrow deeply. The African mudfish may spend more than half the year in a lethargic state in the dry mud, and there are various other fishes which can live out of water. The old-fashioned worm-like Amphibians, known as Cæcilians, have found refuge underground, and there are a good many burrowing limbless lizards and burrowing snakes. The sand-martin deserves to be called a burrowing bird and the same may be said of the burrowing Australian parrot, Stringops, which has given up flight altogether. Among burrowing mammals may be mentioned the Marsupial Mole of Australia, the archaic Golden Mole of Africa, the familiar gentleman in the velvet jacket, the Prairie Dogs, the rabbits and the voles.

It would be interesting to show how well adapted many of these burrowing creatures are to a subterranean life, and how the same sort of fitness has been independently attained by animals which are not related to one another, as is plain enough when we compare a Mole-Cricket and a Mole. But our present point is to indicate the literal truth of the phrase "the living earth," and to unify many of these diverse creatures of the underworld in the light of the idea that the surface of the earth is a dangerous haunt of life—so riskful, indeed, that many animals have been trying for ages to exchange it for some other.

The Brock or Badger.—It is somewhat pathetic to read in a Gazetteer the long list of local names like Brockhurst, which indicate the previously wide distribution of the brock or badger. But, although, this old-fashioned creature is now restricted in its range, it is still holding its own in various parts of Britain, and it is interesting to ask how survival is secured. The badger is a very muscular animal, with a first-class heart and circulation, and a strong wind. Its jaw grips like a vice and cannot be dislocated. Its coat is thick and it puts on so much fat that it can fast in evil days. It has keen senses, shrewd intelligence, a strong will and a capacity for not worrying. It has an extraordinary range of appetite; it cultivates self-effacement; it is nocturnal and a burrower; it holds strictly to sanitary regulations in its "earth" or "set." But we are inclined to attach much importance to the careful education which the mother-badger gives to the silvery grey cubs. She is a stern disciplinarian, punishing them when they are inattentive or foolhardy, and she gradually instructs them, to their lifelong advantage, in all the alphabet of wood-craft. Long life to the badger, for it is a legacy from distant ages, and well worth preserving.

Gideon's Test.—When travelling in Western Baluchistan, Dr Nelson Annandale saw a member of an Indian labour corps carefully skimming water with his hand from the surface of a spring. When he was asked for a reason for his carefulness, the man replied that it was to avoid swallowing a leech. Further inquiry showed the presence of a leech called *Limnatis nilotica* on the borders, and even within the boundaries of the Indian Empire. Many were observed at Robat close to the point at which the Afghan, Baluch, and Persian frontiers meet, and a specimen was got within the district of Seistan, fastened to the tongue of a horse. Now this leech occurs in Palestine, and Gideon's test was evidently one that discriminated between the careless and reckless who drank directly from the water, and the careful and more controlled who lifted the water in their hand to their mouth, and were therefore safe from the risk of swallowing a leech. The agricultural moral is that horses should not be allowed to drink from stagnant pools.

The Flight of Bats.—Everyone is aware that Bats flying at night, or in experimentally produced darkness, do not knock against obstacles. When wires are stretched across a room, bats avoid them, even in total darkness. The wires sound at the least touch, but there *is* no sound. It has been suggested that bats have very keen vision, but the capacity of avoiding obstacles remains when the eyes are covered. It is true that bats have an exquisite sense of touch, but they swerve from obstacles when at some distance off. Dr H. Hartridge writes:—"Bats in full flight and in what appears to be absolute darkness can not only steer round a room and avoid one another, but they can also avoid obstacles such as threads. Further, they can tell whether a door is shut or open wide, or just sufficiently wide open to allow them to pass." Birds dash against the glass window of a room in trying to escape, but bats know better. We are not disposed to abandon the theory of a pressure-sense, allied to the sense of touch, but Dr Hartridge has another suggestion. Bats have acute hearing, and they emit short-wave-length sounds which are near the audible limit of man, and indeed above that of some people. What Dr Hartridge suggests is that when a bat swerves away from an obstacle it is being directed by a specialised sense of hearing. The waves of short wave-length which they emit are capable of "casting shadows" and of "forming sound-pictures." In the barns of many farms there are bats in large numbers, and perhaps some one with abundant material might devise a neat experiment when the time for the flight of bats comes round again. In any case, too little is known about our British bats, and we suggest the desirability of more information in regard to these very useful and very whimsical mammals. The Long-Eared Bat, for instance, is a cheerful and playful creature, said to be easily tamed. Apart from the avoidance of obstacles there are other problems; thus the reproductive peculiarities of bats are in need of more critical study.

AGRICULTURAL EXPERIMENT STATIONS IN CANADA.

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"GOOD and true work is usually abundantly prolific." These words of Lord Cathcart appeared in the address from the Royal Agricultural Society of England to Sir John Lawes on the occasion of the Jubilee of the Rothamsted Experiments.[1] They are remarkably exemplified in the Agricultural Experiment Stations of Canada, the origin, principal achievements and present status of which I propose briefly to outline.

Under the Experimental Farms Act of 1886, passed after Parliamentary inquiry by a Select Committee, and the subsequent study of similar institutions abroad, a central farm at Ottawa for the provinces of Ontario and Quebec; and four branch farms at Nappan, Nova Scotia, for the Maritime Provinces; at Brandon, for Manitoba; at Indian Head, for what were then the North-west Territories; and at Agassiz, for British Columbia, were established under the directorship of the late Dr William Saunders. Under his wise and energetic supervision, aided by carefully selected experts, these five farms entered upon a course of practical and scientific experiments, the results of which have proved of incalculable value to the Canadian agricultural industry.

The five original farms continued for twenty years, when, their usefulness having been abundantly demonstrated, the policy was adopted of gradually increasing the number. Since 1906, when the sixth was started at Lacombe, in Alberta, no less than nineteen new experiment stations have been added; so that to-day the total number is twenty-four. The following statement shows the name, location, acreage and date of establishment of each of the twenty-four farms and stations now in operation:—

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[1] *Journal R.A.S.E.*, Vol. 54, 1893, p. xci.

Farm or Station.	Province.	Acreage.	Date.
Central, Ottawa	Ontario	467	1886
Kapuskasing	Ontario	1,282	1916
Harrow Tobacco . .	Ontaria	49	1909
Charlottetown . . .	Prince Edward Island.	100	1909
Nappan	Nova Scotia . .	460	1886
Kentville	Nova Scotia . .	434	1912
Fredericton	New Brunswick . .	520	1912
Ste. Anne de la Pocatiere .	Quebec	340	1911
Cap Rouge	Quebec	339	1911
Lennoxville	Quebec	455	1914
La Ferme	Quebec	1,200	1916
Farnham Tobacco . .	Quebec	65	1912
Brandon	Manitoba	625	1886
Morden	Manitoba	280	1915
Indian Head	Saskatchewan . .	680	1886
Rosthern	Saskatchewan . .	650	1908
Scott	Saskatchewan . .	520	1910
Swift Current . . .	Saskatchewan . .	640	1920
Lacombe	Alberta	850	1907
Lethbridge	Alberta	400	1906
Invermere	British Columbia. .	53	1912
Summerland	British Columbia. .	550	1914
Agassiz	British Columbia. .	1,400	1886
Sidney, V.I.	British Columbia. .	125	1912

NOTE—The five original stations established in 1886 retain the title of "Farm." In all other cases the term "Station" is used, this being the only distinction thus implied.

The total acreage of the twenty-four farms and stations is 12,484, as compared with 3,472, the area of the original five farms in 1886. In addition, there are eight small sub-stations situated at Fort Vermilion, Grouard and Beaverlodge in Alberta; Salmon Arm in British Columbia; Swede Creek in the Yukon Territory; and Forts Smith, Resolution and Providence in the North-west Territories. At these sub-stations, the land is rented under terms arranged with local farmers.

Early Experiments.—From amongst the large number of experiments undertaken by the five original farms, several typical examples may be mentioned as leading to permanent improvements in Canadian agriculture. In Canada the growing season is comparatively short, but growth is correspondingly rapid. Indeed, the rapidity of growth on fertile land is one of the first things to strike the notice of old country farmers. To obtain the best results, therefore, seeding at the earliest possible moment is essential. This was not generally recognized in the earlier days of the farms; but a series of ten years' experiments definitely determined its importance, and early seeding is now a cardinal principle of good farming in Canada.

Summer fallowing for the control of weeds and the conservation of moisture was introduced into the West in 1885, by Mr Angus Mackay, who for many years was Superintendent of the Indian Head Farm, and who is now Inspector of the Western Farms.

After thirty-three years' experience, the Experimental Farms have shown that fallowed land, first ploughed before July and cultivated as each crop of weeds appear, is the surest safeguard against drought in the following season. The plan has certain disadvantages, which should disappear with the more general adoption of mixed farming and greater diversification of method; but where dependence is placed only on grain the practice of summer fallowing means always a superior yield and sometimes the difference between success and failure.

Interesting and valuable results were obtained from fertilizer experiments carried on for twenty-two years. Amongst these the superior economy of applying farmyard manure in the fresh rather than in the rotted condition was established, and the fertilizing value of clover was clearly shown at a time when this property of the leguminosæ was but imperfectly realized. The circulation of the complete results of these experiments proved of great value at the time.

The introduction into western agriculture of suitable grasses and clovers must also be placed to the credit of the original farms. Awnless Brome Grass, obtained in 1887 from Riga, now ranks as one of the best fodder plants in the West for both pasture and hay. Western Rye Grass, a native perennial discovered by Dr William Saunders and extensively propagated, is another valuable acquisition, and at present both grasses occupy in western agriculture a position similar to that held by Timothy in the east.

Both the common red clover and alfalfa are now entering into western rotations as the result of efforts on the part of the farms to obtain hardy strains and to discover means of resistance to winter-killing.

Central Farm.—Occupying a total area of 467 acres, the central farm is situated within three miles of the Parliament Buildings at Ottawa, near the boundary line separating the provinces of Ontario and Quebec. The land lies from 40 to 80 feet above the Ottawa and Rideau rivers into both of which it drains. It includes a great variety of soil from heavy clay to light sandy loam; but the greater part is either a good dark sandy loam, or a friable clay. The park-like grounds and gardens, picturesque with the growth of thirty-five years, are dotted with the residences of the Director and of the other principal officers, and lead to the numerous farm buildings, including the offices for general administration, the chemical, botanical and other scientific laboratories, barns, stables, dairy, greenhouses, poultry sheds, apiaries and other installations. On a mound with wide prospects of the surrounding country is an auditorium used for the instruction and entertainment of the large bodies of farmers who annually visit the farm. A special branch of the Ottawa electric tramway, constructed in 1909, renders the farm easily accessible from the city. An arboretum of 65 acres, including a fine collection of conifers, and a forest belt of 21 acres, are other features of local interest and value.

Whilst, as intimated, the Central Farm serves primarily the large provinces of Ontario and Quebec, it is also the headquarters whence the work of all the stations is directed and co-ordinated. Nearly all the scientific officers reside at or near the Central Farm, and each of the branch farms or stations is managed by a local superintendent under the director at Ottawa. The work is distributed amongst the following thirteen Divisions, being indicated in each case the year of establishment :—

No.	Division.	Date.	No.	Division.	Date.
1.	Field Husbandry .	1912	8.	Poultry	1887
2.	Animal Husbandry .	1912	9.	Bees	1914
3.	Cereal	1905	10.	Chemical	1887
4.	Horticulture . .	1887	11.	Botanical Entomological . .	1910
5.	Forage Crops . .	1912			
6.	Economic Fibre Plants	1915	12.	Illustration Stations .	1914
7.	Tobacco	1910	13.	Extension and Publicity . .	1913

In these divisions, and at the central and branch farms, are being conducted at present upwards of 2,700 distinct experiments. Only a brief indication therefore of the salient features of the experimental work of each division can be attempted within the limits of the present article.

Field Husbandry.—Much of the work of this division may be defined as the practical application or test, under field conditions, of results obtained by other divisions engaged more directly in scientific research.

In all cases the experiments at the branch farms have relation to local conditions. The value of different commercial fertilizers and of farmyard manure is being tested at many of the stations, and the value of sea weed as a fertilizer is under test at eastern stations near the coast. The study of farm rotations is a special feature, including careful records of cost. Different methods of farm drainage are under study, and much drainage work is being done, especially at the newer branch stations. Other experiments of the Division relate to after-harvest cultivation, sod breaking costs of clearing, depth of ploughing and seeding, green manuring irrigation, nurse crops, dates and rates of seeding, summer fallowing, stubble treatment, the eradication of weeds, the treatment of fence posts and the care and use of farm implements.

Animal Husbandry.—This division has charge of breeding, feeding, housing and general management of horses, cattle, sheep and pigs. Much advantage has accrued to the live stock interests of the Dominion through importation by the Farm of pure bred stock, especially sires, secured mainly from Great Britain and the United States. These have included, during the past thirty years, Clydesdale and Percheron horses; Shorthorns of both the beef and the dual-purpose types; Ayrshires, Holsteins and Jerseys; Shropshire, Leicester, Dorset, Oxford and Corriedale sheep; and Yorkshire, Berkshire and Tamworth pigs. From the foundation stock thus secured, selected pure-bred sires have been distributed to farmers throughout Canada at nominal prices, and at the older farms this work has proceeded for over twenty-five years.

Hundreds of herds and flocks have thus received their first pure-bred impetus, and many purchasers of farm stock have themselves become distributors. At every station in the system pure-bred herds or flocks are maintained to demonstrate (*a*) the possibilities of improvement by properly selected sires, and (*b*) the principles of line breeding, in-breeding, out-crossing, etc. At St. Joachim, Quebec, is a new and enlarged establishment for the breeding, feeding, housing, management and improvement of the French-Canadian horse. Recently the policy has been adopted of exhibiting live stock in open competition; and at the Vancouver, Calgary, and Brandon Exhibitions, during the last few years, the winnings of Experimental Farm Stock have been remarkable. Much is being done experimentally in the "grading-up" of dairy herds by the use of high-class pure bred sires on cross-bred dairy cows and heifers, from which come the great bulk of the dairy products of the Dominion. In some cases from 50 to 66 per cent. of the two-year old heifers have exceeded the production of their dams at maturity.

For many years prior to the war, sheep breeding in Canada, despite the efforts of the Department of Agriculture, was a declining industry; but in 1917 the annual decrease was arrested. The high prices caused by the war stimulated production and the numbers of sheep have materially increased. Comparisons of sheep breeds are now being made at the Central and at two of the western farms. At ten of the farms the work takes the form of the grading-up of flocks by the use of pure-bred rams on common ewes. At Lethbridge, in Alberta, a flock of some 800 ewes has been purchased in order to obtain accurate data as to the costs and profits of sheep breeding under range conditions.

Swine breeding and feeding has always been a main feature. At Ottawa, the Yorkshire and Berkshire breeds are now being compared, the work involving studies in heredity and costs. At branch stations are being tested the most economical methods of keeping brood sows and of cheapening the cost of wintering.

During recent years this Division has planned all the buildings erected on the Experimental Farms, including barns, dairies, piggeries, silos, etc. Close study has been given to the general subject of farm buildings and those constructed embody what is considered to be the best practice as regards economy, durability, sanitation, light, ventilation,[1] convenience, comfort, cheerfulness and efficient accessories. Plans and specifications of farm buildings are furnished free to farmers, the number increasing steadily. Considerable attention has been given to silo construction, and practically every type of silo has been tried. Of great importance was the introductory work by the farms in this connection some fifteen or twenty years ago when the silo was regarded with suspicion. More recently the use of silos has been extended to both the maritime and the western provinces. Feeding experiments in great variety are conducted with beef-cattle, and the work with dairy cattle is also extensive and detailed.

In dairying, experiments are being conducted at different stations to ascertain the best means of milk disposal, whether as milk, butter, cream or cheese. Cream, Coulommier and Stilton cheeses are made. Special dairy work is being undertaken at Lennoxville, in Quebec, where a new dairy barn and dairy were erected in 1919. A new dairy building, recently erected in Ottawa, allows of expansion of the experimental work carried on there. Milking machines of many different makes have received thorough trial at Ottawa, in comparison both with each other and with hand milking. This work has been of special importance during the past seven years owing to the urgent need of production, combined with the dearth of labour. Thousands of dairy farmers have had to face the alternative of giving up or reducing their herds, or of obtaining more help, and the installation of efficient milking machines has at least partially solved the problem. Feeding materials in great variety, records of production and cost, and the diseases of farm live stock from a practical standpoint, have all been the subject of detailed investigation. Preparations used in the control of contagious abortion of cows, septic arthritis in foals and worms in sheep and swine have been carefully tested.

Cereal Division.—The work of this division comprises the production by cross breeding and selection of new varieties of grains and the testing of their suitability for different parts of Canada. Notable successes were secured years ago by introduction of the Preston, Stanley, Huron and Percy wheats, each of which possessed qualities adapted to districts where the old Red Fife was unsuitable. In Eastern Canada the Huron became the most famous, and re-selected wheat of this variety is now most generally recommended for eastern use.

But within recent years no discovery of the Experimental Farms has been more epoch-marking than that of the Marquis variety of wheat, the fame of which has spread through the whole of the North American continent and even to the other side of the Alantic. The full history of this wheat has lately been published

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[1] The Rutherford system for the ventilation of stables, cow byres, etc., has proved best suited to Canadian climatic conditions, and 75 per cent. of the ventilated farm buildings in Canada now use it. The system was introduced by and derives its name from Dr J. G. Rutherford, C.M.G., formerly Veterinary Director General of Canada and now member of the Board of Railway Commissioners.

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in book form by Dr Buller of Winnipeg.[1] It was discovered in 1904 by Doctor Charles Saunders, chief of the Cereal Division of the Central Experimental Farm at Ottawa. The wheat is believed to be the result of a cross between Red Fife as the male parent and an early ripening Indian wheat, known as Hard Red Calcutta. It was one of many experimental crosses, and had been produced in 1892 by Dr A. P. Saunders (a brother of Dr Charles Saunders), when working temporarily with his father during a summer vacation. Marquis wheat remained therefore mixed with other sorts until 1903, when a few grains picked from a single head grown that year formed the stock from which the present wide distribution has been obtained. With the excellent baking characteristics of the Red Fife, Marquis possesses the further advantages of an earlier ripening habit, and prolific yield; so that at the present time the Marquis has entirely replaced the Red Fife as the prevailing wheat grown on the western prairies. It is estimated that 95 per cent. of the western spring wheat is now Marquis and that about 60 per cent. of the spring wheat grown in the United States is of the same variety. At a moderate computation the annual additional value to Canada of this new wheat alone is not less than $20,000,000, or say £4,000,000. Prelude and Ruby wheats are also introductions of the Cereal Division recommended for growth in districts too far north for Marquis.

Important work has also been accomplished with other grains, Banner oats, the Liberty hull-less oat, the Arthus pea and long stem flax being notable examples of useful new varieties. Long stem flax is admirably adapted to districts where flax is grown for fibre.

An important part of the operations of the Cereal Division has been the annual distribution of free samples of seed, grain and potatoes throughout Canada, which, continued over a long course of years, has done much to encourage the use of greater care in the selection and growth of good seed. Extensive milling and baking tests are also carried on by this Division at Ottawa.

Horticulture.—The Horticultural Division was established in 1887, and the present Dominion Horticulturist, Mr W. T. Macoun, has been chief of the Division since 1898. The experiments are carried on at every station and range over a very wide field, comprising the four main subdivisions of vegetable gardening, orcharding and small fruits, ornamental gardening and plant breeding. Here attention must be limited to certain features which have a more or less direct connection with practical agriculture. A vast number of experiments have been made with all descriptions of fruit, and many new varieties of great value have been produced. Of apples thousands of new varieties have been raised from seed of the Fameuse, M'Intosh Red, Wealthy, Northern Spy and other sorts. Out of the many which have fruited, more than 100 have been named as being promising for some part of Canada. The Melba,

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[1] *Essays on Wheat.* By A. H. R. BULLER, D.Sc., Macmillan Company, New York, 1919.

Joyce, Pedro, Winton and Brock are all new apples of good to very good quality and are good croppers of handsome appearance. The work of breeding hardy apples for the Prairie Provinces, begun by the late Dr William Saunders and carried on by the Horticultural Division since 1910, has, it is claimed, laid the foundation for the successful growth of apples over most of the Prairie Provinces. Great saving to fruit growers has been effected by following the advice of the Division, founded upon experiment, in the selection of hardy varieties instead of tender ones which would have been winter-killed. In the past twenty-three years continuous records have been kept of the yields from individual trees. These records have been and will be of great value to the fruit growers of Canada.

In 1907 public attention was drawn to the importance of a change of seed potatoes in order to produce maximum yields; and since that date still more remarkable results have been obtained. It is believed that the present potato crop of Ontario alone could be almost doubled if all the growers would plant only the best seed from sources recommended by the Division as the results of the trials made.

Early Sweet Malcolm and Early Sweet Squaw are two examples of improved varieties of Indian corn produced by the Division for use as a table vegetable and valuable for early ripening. The Alacrity tomato, a variety giving the largest crop of early fruit, has been on the market for several years; it is the result of ninteen years experimental work. Experiments during the last six years in the cultivation of home-grown vegetable seeds have shown that such seeds can be grown quite readily at home, and that they will give results equal to or better than any that can be imported. Other important experiments have been and are being conducted with all kinds of small fruits and vegetables.

Forage Plants.—One of the more recently formed Divisions, this has for its work the variety testing of grasses, leguminous forage plants, field roots and Indian corn, plant breeding, the collection of Canadian wild flora, with special attention to genera and species likely to be valuable as forage plants, and the growth of root seeds in different districts of Canada. Promising results have already been obtained in the production of hardy strains of clovers and grasses, with a view to the lessening of winter killing and the extension northward of the area wherein such forage crops may be grown. Recent experiments with sunflowers for ensilage are giving interesting results, and indicate that sunflowers may usefully be grown for silage in areas that are too cool and dry for the successful production of Indian corn. In connection with the production of home-grown root seed a work of great importance is in prospect, having for its object the standardizing of types and the guaranteeing of pure and acclimatized seed to the trade. The work of the Division is under the direction of Dr M. O. Malte, an expert from the famous plant-breeding station at Svalöf in Sweden.

Economic Fibre Plants.—This Division was established in 1915 as a result of the cutting off from Ireland of the European flax supply. Gradually, under its fostering influence, an important new industry has been established in Canada. The acreage under flax for fibre has increased from 4,000 in 1915 to 31,000 in 1919, whilst the total value of flax fibre products has grown from $399,600 in 1915 to $5,523,900 in 1919. In this year 90,000 bushels of inspected seed of fibre quality, value $967,500, were shipped to Ireland from Canada.[1] The Experimental Farms have materially contributed to these results by growing experimental areas of fibre flax in different parts of Canada, and by the preparation of the fibre thus produced. At Ottawa a flax mill has been installed, and the Division also operates a flax mill and flax growing area at Clinton in Ontario. Much excellent progress has been made towards the introduction and perfecting of flax labour-saving devices. A de-seeder and an improved flax scutcher are amongst the new flax fibre appliances now in successful operation at Ottawa. Hemp growing is also being studied, and some excellent plots of hemp have been grown at the Central Farm.

Tobacco.— This Division, under the control of a tobacco expert from France, was established in 1910. It deals with breeding, variety tests and cultural methods, fertilizers and the manufacturing and warehousing of tobacco. It conducts two Tobacco Stations, one at Farnham in Quebec ; the other at Harrow in Ontaria. The production of tobacco in Canada is gradually increasing, and in 1920 there was a record crop of over 48,000,000 lb.[2]

Poultry.—This, one of the original departments established in 1887, has like other divisions greatly increased in complexity of operations; but, for twenty-five years under the management of the late Mr A. G. Gilbert, a vast amount of useful pioneer work was accomplished. Trained poultry men are now placed at local stations, and experimental work is being conducted on well considered plans. The main lines of work include artificial incubation, breeding, problems relating to vitality, fertility and egg production; systems of brooding and rearing, cross-breeding, early maturity, trap nesting, table poultry and experiments with turkeys, geese and ducks. Poultry diseases and parasites receive careful attention, as well as important economic problems dependent upon chemistry. Poultry buildings are planned according to the best modern ideas, and specifications are furnished free to interested applicants. There is an active spring demand for breeding stock and eggs. A recent and popular feature has been the institution of egg-laying contests, intended to stimulate good poultry keeping, and eventually to be the basis for the registration of pure-bred poultry. Poultry survey work conducted by the division is giving gratifying results. It is an endeavour to get groups of farmers in various localities to keep accurate records, and this work leads naturally to the better housing, breeding and care of farm poultry.

Bees.—During the seven years that the Bee Division has been in existence great progress has been made in the knowledge of profitable bee-keeping under Canadian conditions. A study has been made of honey plants, including new species peculiar to the Canadian flora. Much attention has been given to the two main problems of Canadian bee-keeping, viz. :—wintering and the control of swarming. Methods of breeding, feeding, manipulation and marketing are all under careful investigation.

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[1] *Monthly Bulletin of Agricultural Statistics*, July 1920, p. 166.

[2] *Ibid.*, January 1921, p. 27.

Chemical Division.—From the beginning, the foundational science of agricultural chemistry has occupied a foremost position in the experimental farm system. Not only has the Chemical Division under the Dominion Chemist, Dr Frank T. Shutt, who is also Assistant Director, engaged in numerous experiments of strictly scientific character, but the chemical laboratory with a large staff of qualified expert assistants has been and is indispensable for the solution of problems affecting work in other divisions of the farm system. The activities of the Division have been still further widened through recourse to it by other Branches of the Department of Agriculture, by other Departments of the Dominion Government and especially during the war by the military authorities for investigations connected with food supplies and stores. Allusion has already been made to the early work of this Division, but the following are among the more important questions which have occupied attention. Experiments to determine the value of clover, alfalfa and other leguminous plants for the maintenance and increase of soil fertility have largely influenced and extended the cultivation of these important crops. Much work has been done in connection with soil analyses, especially for determination of the natural and agricultural value of many types of soil in the Prairie Provinces and in British Columbia ; the influence of irrigation on the composition and "strength" of wheat ; the conservation of soil moisture ; and determination of the influence of meteorological factors on the composition and yield of wheat and sugar beet. Experiments with manures and fertilizers have proved of great practical value, and dissemination of the knowledge acquired has been the means of saving much of the plant food that otherwise would have been lost.

In addition to the purely experimental work, analyses are undertaken of fodders, feeding stuffs, fertilizers, soils, well waters, insecticides, fungicides, etc. The majority of the samples of these materials are submitted by farmers throughout the Dominion to whom much useful advice is furnished in relation thereto. The elimination of the German potash supplies as a consequence of the war caused special study to be given to Canadian sources of this substance, and at the present time promising field tests are being conducted to ascertain the value of a nitro-potassic fertilizer, prepared by the drying and grinding of sea weed.

Botany and Entomology.—Originally, agricultural botany and agricultural entomology formed one division under the late Dr James Fletcher. Upon his death in 1908 separate divisions were created under botanical and entomological experts from England. Great progress has since been made in the organization, development and equipment of each of these divisions. The law has been strengthened by the Destructive Insects and Pests Act of 1910, which, with subsequent amendments and statutory regulations, is designed to prevent the importation of injurious pests. An efficient inspectorate has been created to enforce its provisions, so important in their safeguarding value. The investigations conducted at the Central Farm are now supplemented by local field laboratories under qualified scientific observers. During the administration of the late Dr Gordon Hewitt, Dominion Entomologist, who died in 1920, the Entomological Division became in 1914 a separate Branch of the Department of Agriculture, and so passed administratively from the Experimental Farm system. At present, the Division of Botany falls into the two great classes of Economic Botany and Plant Pathology. In the former, the work consists in the study of medicinal, poisonous and other plants, such as chicory, mustard, wild rice, soy bean, caster oil plant, opium poppy, etc. Different strains and varieties of fibre plants are also studied, and special attention is given to the life history of weeds with a view to their control or eradication. Specimens sent by correspondents are identified, and advice is given where required. An herbarium is maintained and the Division has also charge of the Ottawa Arboretum.

In plant pathology the work carried on is extensive and varied, the investigations including the diseases affecting forest trees, fruit trees, cereals, small fruits, potatoes, tobacco and vegetables. In the West, plant pathological laboratories have been established with the special object of studying wheat rusts which occasionally inflict enormous damage under rust-inducing conditions, as was the case in 1916 when the loss to farmers was roughly estimated at about $50,000,000 (£10,000,000).[1] A very important work has been successfully carried on in the control of potato diseases, such as Black Leg, Powdery Scab, Common Scab, Curly Dwarf, Late Blight, Leaf Roll, Mosaic Disease and Rhizoctonia. The Division also issues free of charge to applicants cultures for the treatment of clover and alfalfa seed.

Illustration Stations.—This Division, formed in 1916, serves as a connecting link between the farm system and the farmer. A representative farmer is chosen in each locality, and on a certain area of his farm (45 acres in the West) are illustrated the best rotations, varieties of crops and cultural methods, as determined by the Experimental Farms. At present the approximate total number of these Illustration Stations, which are beginning to prove of great practical value, is seventy-five with a total acreage exceeding 2000.

Extension and Publicity.—With the large recent growth and development of the Experimental Stations has arisen the necessity for improved methods of making known the results for practical adoption. To meet this need a Special Extension and Publicity Division was formed in 1914. Two chief methods adopted are the placing of exhibits from the farms at agricultural fairs and shows and extension of the departmental mailing lists. In addition, the results are made known to farmers (1) by correspondence; (2) by the publication of numerous bulletins and reports;[1] and (3) by the issue of a special sixteen page pamphlet entitled "Seasonable Hints." This, now its fifth year, contains brief timely articles and notes on farm topics and is issued thrice yearly to a mailing list of some 300,000 farmers. In addition to numerous individual visits large excursions are arranged annually during the summer to each farm; and the number of farmers taking part therein is sometimes as many as 1000 to one farm in a single day.

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[1] *Monthly Bulletin of Agricultural Statistics*, March 1917, p. 62.

Cost and Personnel.—The cost of these multifarious activities is provided for by annual votes of the Dominion Parliament. For the current fiscal year ending March 31, 1922, the total Experimental Farm Appropriation amounts to $1,485,675 (£305,276), divided as follows:—Maintenance of Farms, $1,245,000 (£255,822); travelling expenses, $41,775 (£8,584); Administration of the Destructive Insects and Pests Act, $73,900 (£15,185); Flax growing, $25,000 (£5,137) and Public Works, $100,000 (£20,548). Large as these sums appear to be their relation to the results achieved may be gauged by the fact that from recent moderate and conservative computations it is estimated that the value to the farmers of Canada of the Dominion Agricultural Experiment Stations is not less than $60,000,000 (£12,000,000) per annum. The total numbers of employees is about 935, of whom 297 comprise the technical and clerical staff and 638 are labourers, the latter being, however, reduced to about half the number during the winter.

Conclusion.—After an existence of thirty-five years, the Experimental Farm system of Canada has abundantly justified the wisdom and foresight of the statesmen who established it. At the same time its great success has been due largely to the scientific skill and enthusiastic zeal of those who have directed operations, including the large and increasing staff of scientific officers. Mention has already been made of those who have passed away after years of devoted service, and it will not be considered invidious to name also others whose veteran services are still happily available. Reference has already been made to the late Dr William Saunders, Director from 1886 to 1911, of whom as the original architect of the Dominion Experimental Farms, it may to visitors be truly said:—*Si monumentum quæris, circumspice.* He was succeeded by Dr J. H. Grisdale, who, promoted to be Deputy Minister of the Department of Agriculture in 1919, was, in turn, succeeded by the present Director, Mr E. S. Archibald, whose kind assistance in the compilation of this article the writer desires gratefully to acknowledge.[2]

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[1] An Annual Report of the Experimental Farms Branch has been issued since 1887.

[2] In addition to the Experiment Stations herein described, agricultural experiments in great variety are conducted by the Provincial Governments in connection with the Agricultural Colleges, including those of Truro, N.S.; Macdonald, Oka, and Ste. Anne de la Pocatiere, Quebec; Guelph, Ontario; and the Universities of the Prairie Provinces and of British Columbia.

COMMON WEEDS.[1]

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Edinburgh and East of Scotland College of Agriculture.

IX.—PERENNIAL WEEDS WITH GREENISH FLOWERS.

SOME of the worst weeds are deep-rooted perennials with small flowers, greenish in colour but rendered more conspicuous by being grouped in close clusters. The Bracken fern, Horsetail and Mosses are included in this section, though they do not bear true flowers and seeds, but are propagated by minute spores.

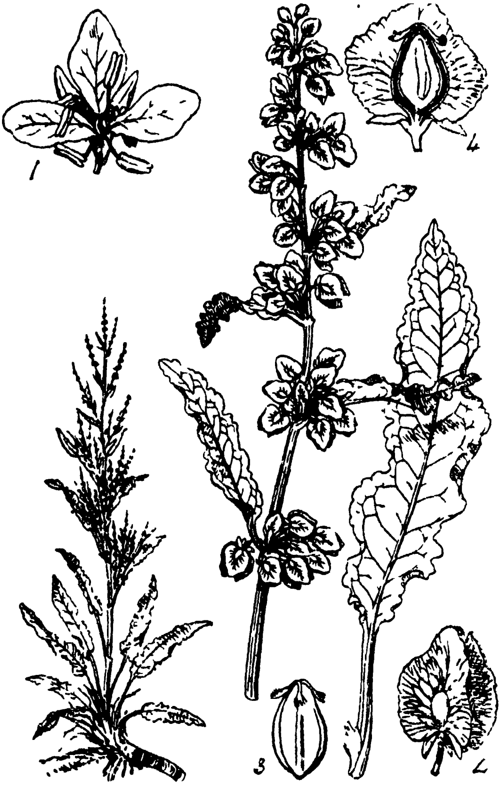

FIG. 24.—CURLED DOCK (*Rumex crispus*).
1. Flower. 2. Fruit, outside. 3. Pistil.
4. Section through Pistil.
(*Standard Cyclopedia of Agriculture.*)

Docks.—The docks and sorrels of the genus Rumex (order Polygonaceæ) have a flower structure differing only slightly from the Redweeds or Polygonums described amongst the annuals. The taproots of the commoner Docks penetrate deeply into all kinds of soil, even stiff clay, and from the crowns arise the well-known "docken leaves." These are large, up to a foot long, undivided, and form a rosette. Later come the long flowering stems, bearing smaller leaves and ending in clusters of green flowers which turn reddish as the seed ripens. Curled Dock (*Rumex crispus*) has elongated leaves with wavy margins (Fig. 24); Broad-leaved Dock (*R. obtusifolius*) has leaves broader at the base and tapering to a blunt tip, but the leaf form varies, as hybrids occur. The fruits consist of glossy triangular nuts, hidden in three triangular scales, which are distinctly toothed on the margin in the broad-leaved dock, but are broader, rounder, and with margins nearly entire in the curled dock (Fig. 24-2). The brown triangular nut with sharp edges is a common impurity in clover seed, and is one of the scheduled noxious weeds. Introduced into young grass with the seeds, the dock seedlings have time to become established during the grass years. It is important to prevent flowering as the seeds are known to retain vitality for eight years or more. When the grass is broken up, the deep taproots are either broken or turned more or less out of the soil. If left on the surface dock roots soon throw out new rootlets, hence it is advisable to collect them and cart them off the land. Should the dock crown be broken off, the taproot sends up, not one new crown, but a dozen or more, so that hoeing or spudding docks rarely kills them unless repeated often. In the case of odd docks on a lawn, a pinch of sulphate of ammonia on the broken crown will kill the root.

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[1] This is the fifth and last instalment of an article on "Common Weeds," which will be followed by articles dealing with other farm pests.

Sheep's Sorrel (*Rumex acetosella*) is much smaller than the docks. The underground parts are slender, not usually very deep, and form a close or open mat which throws up numerous shoots. The flowering shoots are rarely more than a foot high, the leaves are triangular, about an inch long, and easily recognised by the two projecting ears at the base (Fig. 25). The leaves and stems are often red, especially in dry situations, and have an acid taste similar to rhubarb and the larger sorrel. The acidity is due to poisonous oxalates which may be injurious to stock if eaten in quantity. The fruits fall from the plant enclosed in the brownish dried perianth; they are smaller than those of the docks, more bluntly triangular, and rather pale brown or speckled. They are common impurities amongst the smaller clover seeds (white clover and alsike), and thus reach arable land in grass seed mixtures. Sheeps sorrel is one of the first plants to appear on bare sandy or peaty soils, also in woods where branches have been burned, and on moors after heather burning. In arable or grassland it frequents the lighter soils rather than the heavy, and its abundance generally indicates deficiency of lime (Vol. IV., July 1921, p. 287). The effect of lime and basic slag is to increase the fertility and to encourage plants that suppress the sheeps sorrel.

Sorrel (*Rumex acetosa*).—This resembles a small dock but can be distinguished by the acid taste, hence the common name Sourock. It resembles a dock by having only one or two flowering stems from the crown of a thickened underground stem, but this is not such a distinct taproot, nor is it so deep-rooted as in the dock. Sorrel differs from sheep's sorrel in its thick rootstock, fewer and taller flowering stems, and the larger leaves with a long stalk and less conspicuous ears. The seeds are intermediate in size between those of dock and sheep's sorrel, and they are not so common in seed samples, probably because flowering and seeding take place mainly in old grassland or in waste places. Sorrel prefers the heavier soils that have become acid. It has been noted as increasing rapidly in meadow hay continuously manured with farmyard manure, and experiments show that dressings of lime and mineral manures weaken the Sorrel considerably.

Stinging Nettle (*Urtica dioica*).—The perennial nettle is a larger plant than the annual nettle, and instead of a simple root, the older plants have long branched underground stems that give off numerous leafy shoots. A single plant may occupy a patch of several square yards, all the leafy shoots being connected underground by a system of white runner-stems. Where nettles grow wild, it may be seen that some clumps bear seed, whereas others have only stamens in the flowers and the pollen is scattered like shrapnel by a sharp jerk of the mature stamens. New plants are produced either from seed or from fragments of underground stems bearing buds. On breaking up waste land, it is a task of

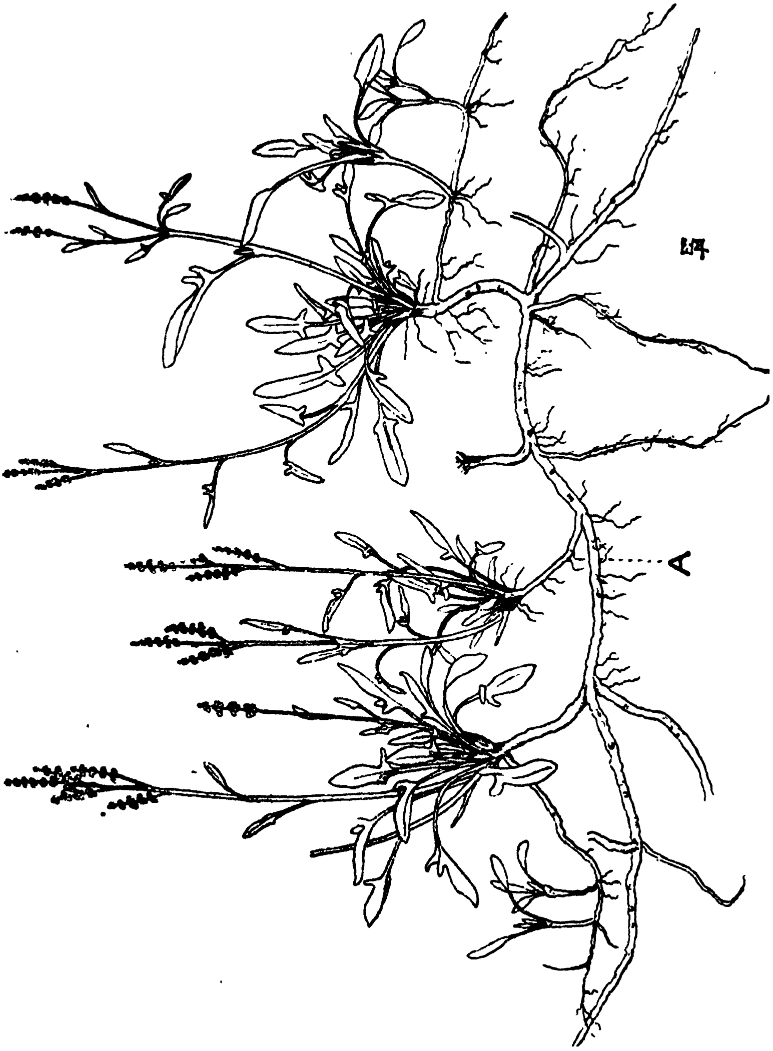

Fig. 25.—Sheep's Sorrel.
A.—Creeping Underground Stem.
(*Weeds of Farmland*, W. E. Brenchley).

several years to clear out all the wrack-like fragments from the soil. The nettle is an indicator of fairly rich soil, so that it tends to be a plant of the waste-heap or hedge-bank where decay is active, and on hill-farms at the higher altitudes, it is a typical weed of the folds or wall-bottoms where sheep lie. It is not a serious weed on arable land except where it extends in from hedge-bottoms. On old grassland nettle becomes a weed when it grows rapidly and kills out grasses and most other plants. These patches may be reduced by repeated mowing, whenever the shoots are tall enough to cut, which means several times a year. Nettles are sensitive to common salt (6 cwt. per acre) and kainit (10–15 cwt. per acre). Another device for small patches is to cover them with sheets of tarred paper, pegged and weighted down, and kept on till the nettles are dead. In its proper place the nettle is a useful plant. Amongst other uses it has long been known that the stem contains a valuable fibre comparable to flax, but not easily obtained clean enough to weave. During the cotton blocade of the war years, the nations of Central Europe made considerable progress in the manufacture of this fibre, and it is possible that the nettle will become a textile fibre of commercial value (W. E. Brenchley in *Science Progress*, 1919). Nettle hay has been found to be useful fodder, as the stinging hairs are harmless when dried. The leaves and seeds can be made into "nettle meal," said to stimulate egg-production in poultry.

Plantains and Ribworts.—Narrow-leaved Plantain (*Plantago lanceolata*) is common in pastures, and though less common on arable land it may become a persistent weed if allowed to seed. It has a close rosette of long narrow leaves, about half-an-inch broad, something like a broad grass, hence the name Ribgrass, though plantain is not a true grass. Long bare stalks carry the head of flowers ("carl doddies"), about an inch long in this species. The elongated brown seeds, ⅛th inch long, rounded on one side with a groove on the other, are common impurities in grass and clover seeds. Whether this Ribwort is to be considered a weed or not depends on how it occurs. It has long been included by sheep farmers in grass-seed mixtures, as it persists in drought, either on light or heavy land, and is grazed by sheep. At the present time it is almost entirely displaced by wild white clover which is just as resistant and is better grazing. Broad-leaved Plantain (*Plantago major*) has leaves nearly as broad as long, and the flower-head is much longer (Fig. 14, July 1921, p. 288). The fruiting heads are collected for cage-birds. The seeds are smaller than those of the other Plantain, and are not so common in seed samples. This Ribwort frequents roads and trodden places about gates, and may become a weed in bare grassland. Several other Plantains occur, but not often as weeds in Scotland. The Ribworts have a compact tuft of strong roots at the base of the leaf rosette, but no runners. They are thus fairly easy to control in arable land. Their chief opportunity is bare places amongst young grass. In older grass they are checked by close grazing if the herbage is coarse, or by sulphate of ammonia (1½ cwt. per acre) followed by basic slag, 8 to 10 cwts. applied in autumn.

Lady's Mantle (*Alchemilla vulgaris*) is a perennial and a larger plant than the annual species (Vol. IV., April 1921, p. 11). It has almost circular leaves (2 to 5 inches broad), folded like a fan when young (Fig. 26), and in the morning often beaded with drops of water along the margin, or holding water like a cup. The root stock is brown and scaly, without runners. The flowers occur in greenish yellow clusters of minute florets without petals, and the small nut-like fruit ripens enclosed in the green sepals. In arable land the annual Lady's Mantle is the commoner weed, but in grassland the perennial one may be abundant. On poor bare pastures on dry land it tends to become a conspicuous weed and is an indicator that the land needs improving. The plant seems to have some value as it is grazed by stock, and where Lady's Mantle is a weed in lawns or policy-parks it can be checked by grazing with sheep.

Couch-Grass, Wrack or Twitch (*Triticum or Agropyron repens*).—Under many names this pest of arable land is known almost every where. It has long white slender underground stems which grow rapidly in open arable land; the absence of swellings distinguishes couch from the Onion Couch (see following page). The leaves and stems of couch are covered with minute hairs, whereas rough-stalked and other meadow-grasses (*Poa*) which sometimes form runners, have smooth leaves; several hedgerow and woodland grasses have hairy leaves and also runners, but they do not often occur as weeds in arable land. The ears of couch resemble rye-grass (*Lolium*), but on examination the groups of florets will be found to be set on with the broader side next the axis, not the narrower edge as in rye-grass. Arable land after cleaning becomes colonised with couch-grass mainly by the underground stems from plants round the margins, or from broken fragments left in the

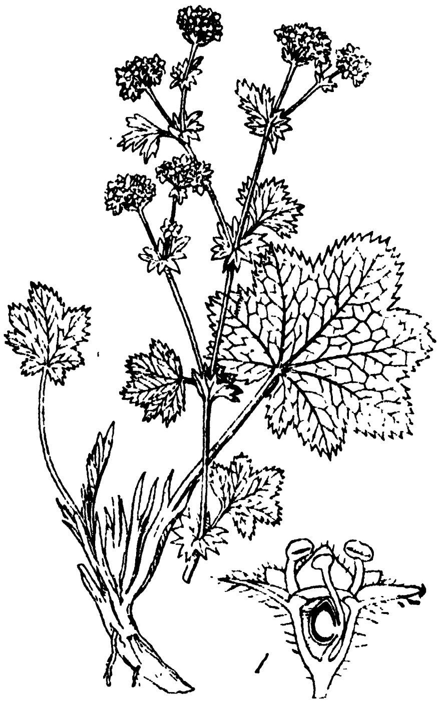

FIG. 26.—LADY'S MANTLE.
Rootstock, Flowering Branch, and Section of Flower (1).
(*Standard Cyclopedia of Agriculture.*)

land. Seedlings may occur, but on rubbing out fruiting ears of couch fully ripe grains are rather uncommon, nor is the seed often found in seed samples. Where land is dirty with Couch-grass it will be a weed in young grass, but later the couch disappears and is rarely reported in herbage analysis of older grassland; thus one way of dealing with wrack-infested land is to leave it under grass. Another method is to sow thickly vetches or some other smother-crop. Couch-grass is not without some value, it is abundant on some sewage meadows where the foggage is cut regularly for cattle. There is a market for the underground stems for medicinal purposes, and as raw material for making a coarse paper, though neither of these have been developed in Britain. The treatment for Couch-grass and Onion Couch is thorough cleaning. After the soil has been loosened and turned over by plough or cultivator, long-toothed harrows are fairly effective in collecting the underground stems, and stacks of these can be brought together. This treatment is more effective on light soils than on heavy, because in wet or heavy land the underground parts are broken and pieces are left embedded in clods of soil. When the ploughed land is dry, these clods may be broken by rolling, and the wrack collected by harrows. Early breaking up of the land allows fragments to dry up or to be frosted, and another opportunity for cleaning comes in preparing the land for seed. The heaps of wrack may be burned or collected into large compost heaps, mixed with lime or gas lime, and left for a year or more till decayed. As the outside of these heaps become covered with a growth of wrack and other weeds, it is necessary to turn them over occasionally to bury all green plants.

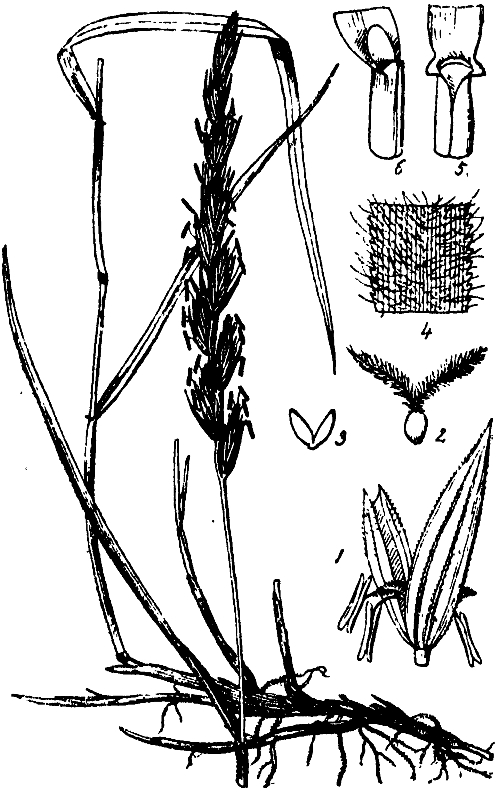

FIG 27.—COUCH-GRASS.[1]
1. Floret. 2. Fruit. 3. Nectary. 4. Portion of a leaf. 5. Base of leaf. 6. Base of leaf of Bent Grass.
(*Standard Cyclopedia of Agriculture.*)

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[1] The ear should be shown as an extension of the leafy shoot.

Cultivation during root-crops helps to uproot some of the Couch-grasses, but this alone will not clean dirty land.

Onion Couch or Bulbous Oat-grass (*Arrhenatherum avenaceum*, var. *tuberosum*, or the older name *Avena elatior*).—This under other

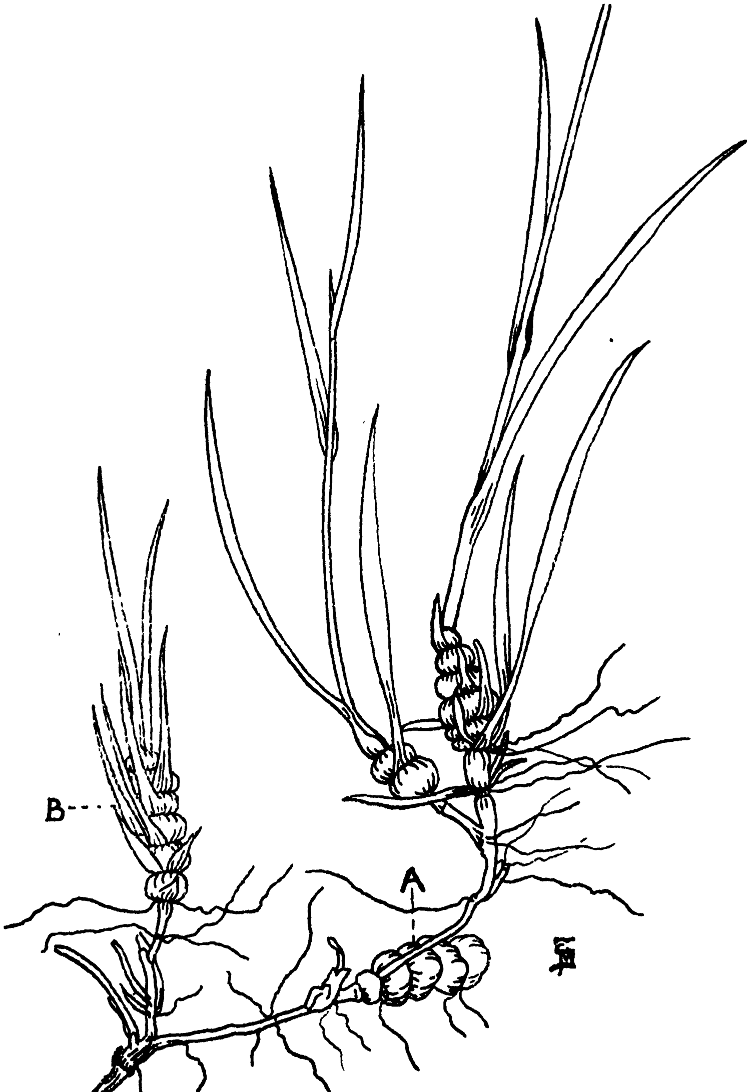


FIG. 28.—ONION COUCH.
A.—Swellings on underground stems.
B.—Leaves from nodes between swellings.
(*Weeds of Farm Land*, W. E. Brenchley).

local names, pearl-grass and knot-grass, is a well known weed, especially on light and medium soils. It is a variety of Tall Oat-grass or French ray-grass, a useful hay grass. The Bulbous Oat-grass is distinguished by the large bead-like swellings at the base of the lower leaves or deeper underground (Fig. 28). The leaves and green stems are almost smooth, but the joints on the stem carry fine short hairs, which are not present in the tall oat-grass. These two varieties have been tested and, provided the seed supplied is the true tall oat-grass, there is no reason to believe that it will turn into the bulbous or weed variety. The swollen knots or "onions" of the weed variety contain a large food supply, and give rise to new plants if left in the soil, and even when collected into a heap they do not decay for a considerable time. Tall oat-grass is very common on road-banks and round fields; generally this is the bulbous variety and, as it forms seed abundantly, it probably disseminates it over arable land.

Rushes.—Where wet places have been reclaimed, Rushes tend to appear as weeds when the land has been put down to grass, but they are not common weeds of arable land. Some Rushes (*Juncus effusus, etc.*) form close tufts of quill-like shoots with flower-groups that come off at the side near the tip. Others, often known as "Sprets" (*J. articulatus*), have wider spreading underground stems, bearing finer leaves and loose groups of flowers at the top of the shoots. All Rushes are indications of excessive moisture, hence they generally appear first in the furrows and depressions in a field, or where water comes to the surface from a choked field-drain. Drainage is the first step in eradication. Cattle often graze the shoots where the patches are not too dense. Mowing is also useful in starving the plants.

Field Rush (*Luzula campestris*) is a low plant, up to a foot high, common in dry moory pastures. It is easily recognised by the grass-like leaves and stems with long cottony hairs; the flowers are in brown tufts. This weed is a sign of poverty, to be checked either by top-dressings of manure, or by ploughing and cropping.

Bracken (*Pteris aquilina*).—The large fern-fronds arise singly, not in tufts as in other large ferns, from a black underground rhizome to be found about six inches to a foot below the surface. Like all ferns, it has no seed-bearing flowers, but the plant is reproduced by spores. These may be found in spore cases which, in the bracken, form a brown line along the leaf-margin, covered by the downward folded edge of the green frond. The bracken is rarely seen in arable fields, and only where the land has been recently broken out of bracken. After a short rotation of cropping it may re-appear in a few years when land has been laid down to grass. The underground stems contain a large supply of food, and they are not easily uprooted, even by ploughing, while broken fragments soon produce new fronds. The bracken is a serious pest in old grass and on hill farms, where it gradually takes possession of the deeper soils. The usual method for checking it is by destroying the green fronds and thus starving the plant. Eradication has followed from "switching," that is breaking or cutting the young fronds before they uncurl and while they are brittle; this can be done by scythe, by a bent stick or by a stick with a piece of thick wire to be used like a scythe or flail. New fronds will be produced again the same season, hence switching has to be repeated two or more times a year, but the method will kill out the plants as they never have green leaves to replace the waste. A less effective method is to mow the leaves when they are nearly full grown, as a rule in July, but this has the advantage of saving labour. If the ground is not too steep or rough, a mower set high or a special machine ("thistle-cutter") may be used instead of the scythe. Where the bracken is neither tall nor dense, one mowing generally clears the ground for that season, but it will have to be repeated a year later. Experiments have been made by spraying bracken with a 5 per cent. solution of sulphuric acid in water (*Trans. Highland and Agric. Soc.* 1916). This at once damages the fronds, but does not always kill them completely, and has not come into general use.

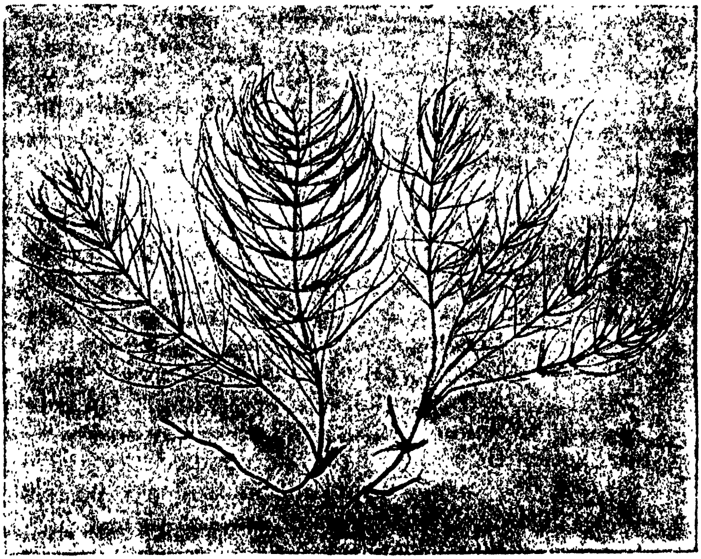


FIG. 29.—HORSE-TAIL.
Green barren shoots from creeping underground stem.
(*Common Weeds*, H. C. Long).

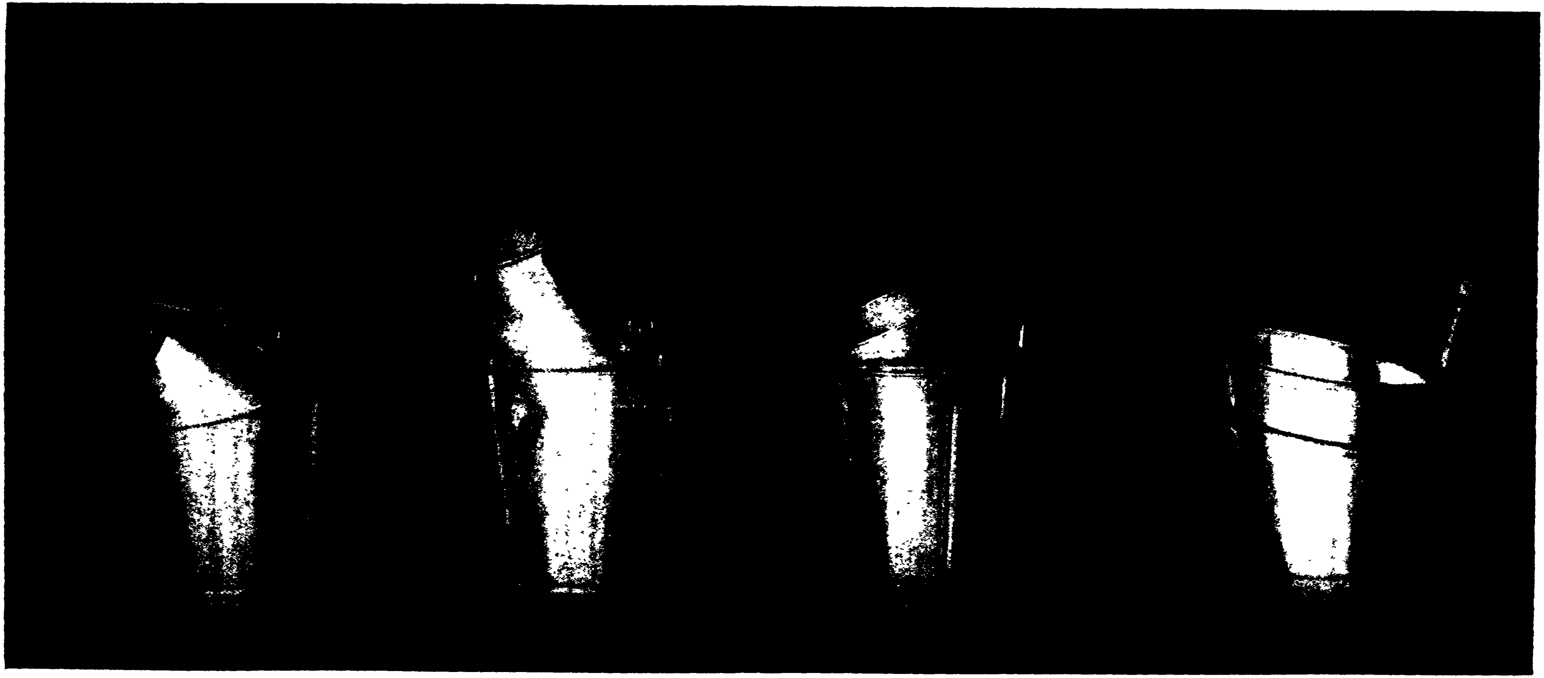
Field Horse-tail (*Equisetum arvense.*)—This plant once seen is easily recognised again. Like the fern it has spores, but produced from a cone-like head borne on the tip of an erect pale yellowish unbranched stem found about April, and sometimes called "puddock pipes." The green shoots appear later with an erect main stem with numerous branches at each joint (Fig. 29). Both kinds of shoots come from buds on the deep-rooted underground stems, not unlike thin rusty wires. In soft soil these rusty stems pull out, but in heavy wet soil they snap and fragments are left still rooted. Other species of horse-tail are water plants growing in dense patches in shallow water, and the field horse-tail still retains a preference for wet places, such as ditches, or land wet in winter. Horse-tail and colts-foot are often the first plants to appear on recently exposed wet clay along streams, or where fields have been turned up in draining. The first step in treatment is to improve the drainage, and by liming and cultivation to break down the clay into finer tilth; the result is that the underground stems are brought to the surface and wither. In grassland, improved drainage encourages a stronger growth of grasses and the horse-tail is smothered. The weed is generally avoided by stock, but cases of poisoning have been reported.

Mosses.—Deterioration of grassland is frequent through excessive growth of various mosses, which are rapidly propagated by spores or by broken fragments capable of renewed growth in a few days. Moss, or "fog" as it is sometimes called, is most evident in the spring months, so that the pastures look green though deficient in grasses. A certain amount of moss is probably useful as protection for the younger herbage and white clover, but excessive "fog" means reduced grazing. It may arise in different ways and be caused by distinct kinds of moss, including the following:—

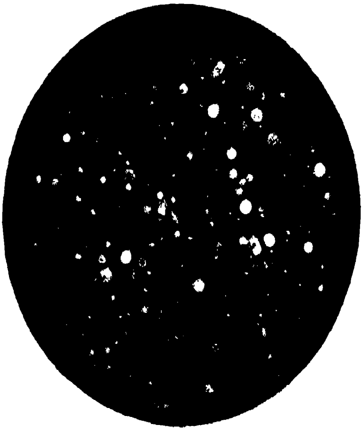
(*a*) Mosses that frequent wet places, and are checked by drainage, either open sheep drains or tiles.

(*b*) Increase of mosses as a result of deficient grazing. On benty pastures, bent-grass (*Agrostis*), sheep's fescue (*Festuca ovina*), Yorkshire fog (*Holcus*), sweet vernal (*Anthoxanthum*), etc., are left ungrazed and, in the turf or sod, mosses of a drier type are encouraged. The treatment is to encourage better herbage by top-dressing, or to change the grazing, cattle replacing sheep, or the reverse.

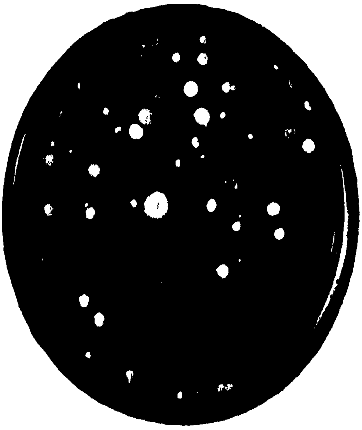
(*c*) Mosses also come as a result of over-grazing. On grass fields (*e.g.* in the South of Scotland) grazed by sheep in winter and spring till almost bare and puddled, the grasses. etc., recover slowly and meanwhile mosses take possession of bare places. It is a common practice to rest such fields during the summer, but even then the taller herbage may fail to smother the moss. One advantage of wild white clover is its quick recovery after winter or drought, but it will not check the mosses if the soil is acid, hence the benefit of basic slag and lime. Where mosses are too abundant considerable improvement may be obtained by superphosphates. The effect is seen in a few dry days, the moss lying loose, and withering. In one case of a benty hill pasture treated with 5½ cwt. of superphosphates, moss was at once reduced from 20 per cent. to a small amount and three years later there was only 1 per cent. of moss present. The effect on herbage was to reduce the grasses about 10 per cent., but to increase the Leguminosae (clovers, etc.) by about the same amount. In another case—an enclosed field of a cocksfoot mixture turning into bent—an annual dressing of 4 cwts. per acre of superphosphates for five years reduced the moss from 45 per cent. to 8 per cent.; the grasses were decreased about 8 per cent., but the clovers increased 9 per cent. (*Jour.*



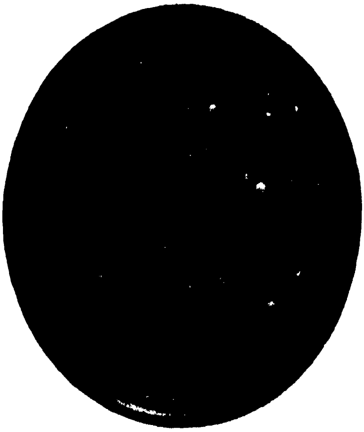
Milking Pails.



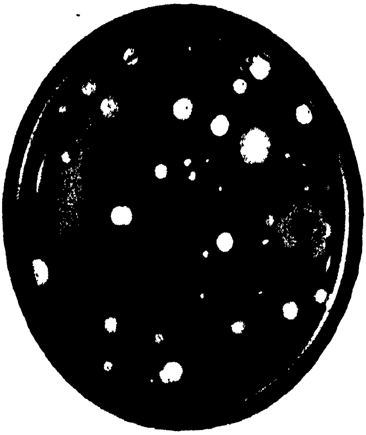
(1) Milk from Pail A.
No. of Colonies 640.



(2) Milk from Pail B.
No. of Colonies 130.



(3) Milk from Pail D.
No. of Colonies 170.



(4) Milk from Pail E.
No. of Colonies 100.

Whey-Agar, Petri Dish Cultures, each inoculated with $\frac{1}{100}$ c.c. Milk, and incubated for 10 days at 22° c.

Board of Agriculture, xxi. Dec. 1914). In some cases basic slag tends to benefit mosses, but if white clover is increased it will replace them. Top-dressing can be assisted by the toothed harrow or a disc harrow, which tears out the moss and also breaks the surface of the soil.

THE COVERED MILKING PAIL AS A FACTOR IN CLEAN MILK PRODUCTION.

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In this country at the present time a considerable amount of attention is being directed to the question of the production of clean milk. An attempt is being made to interest the consumer in the importance of a clean milk supply and to make him realise the dangers existing in the present unsatisfactory state of affairs. If this attempt is successful, it is hoped that an increased demand for clean milk will follow. It, therefore, behoves the producer to consider any methods which may possibly be of value to him in meeting this demand.

It has long been recognised that one of the main factors, if not the chief factor, in clean milk production is the condition of the cow. If the cow is kept clean—particularly during milking—she will yield milk of comparatively low bacterial content. If, however, the udder and flanks of the animal are allowed to become caked with manure, it is practically an impossibility to obtain clean milk by the ordinary milking methods. The importance of the condition of the cow has been emphasised in a former publication of this College (1).

Contamination of milk during milking is largely due to particles of dirt, etc., falling from the skin of the animal into the milking pail. Hence the smaller the area of the opening in the latter the smaller the amount of contamination from the cow. This is the principle of the covered milking pail.

The possibilities of the covered milking pail have been fairly extensively investigated on the Continent and in America. In this country, while the general advantages of the covered over the open type of milking-pail have been demonstrated (2), (3), no attempt has, so far as the writer is aware, been made to study systematically the covered milking pail as a factor in clean milk production. It was, therefore, decided to carry out a series of experiments with a view to ascertaining :—

(1) The comparative merits of several types of covered milking pail at present in use.

(2) The lines along which they might possibly be improved.

Description of the Pails.—Four types of covered pails were tested against pails of the ordinary open type. The pails employed were :

A. The open pail. In Experiments 1 and 2 an ordinary metal pail of the "luggie" type was used—*i.e.* with a vertical handle on one side. The mouth of the pail was 12 in. in diameter. In Experiment 3 the open pail was of the usual type, with semicircular hinged handle ; the mouth was circular, 11½ in. in diameter.

B. A covered pail, with opening 6 in. in diameter in the lid, which is fixed. The opening is inclined at an angle of about 30° to the horizontal. The height of the pail is about 20 in. to the top of the opening.

C. Pail B with a metal strainer, consisting of a single layer of gauze, which fits into the opening. The mesh of the gauze is about $\frac{1}{50}$ in. in diameter and the straining surface is so arranged that it is slightly convex. Surrounding the strainer is a metal band continuous with the framework. When this pail was designed it was thought that the convexity of the strainer would cause any sediment which accumulated to fall down and collect in the metal band and so prevent it being washed by the milk in the subsequent milking.

D. The Ben Davies pail. This is a covered pail with an oval, almost vertical opening, the longer diameter of the opening being horizontal. The opening (7 in. × 4¼ in.) is in the side of the fixed cover. Height to top of opening, 15½ in. The pail is provided with a second handle on the side, and a flange on the cover above the opening tends to prevent dust which has accumulated on the cover from falling into the milk when the pail is emptied.

E. was designed by Professor Cossar Ewart. It consists of an ordinary pail with movable cover, in which there is an oval opening, 7½ in. × 6¾ in., inclined at about 30° to the horizontal. At the base of the opening there is a metal strainer—mesh, $\frac{1}{25}$ in. square, and under this a thick cotton strainer is held in position by a metal ring, which fits into a groove on the under side of the cover. Height of pail to top of opening, 16 in.

The pails used are shown in Plate I.

Methods of Examination.—The samples were taken in sterile bottles by means of sterile dippers. They were immediately cooled in water and were examined in three to four hours after milking.

The methods employed were those described in a previous paper (4). For the benefit of those to whom the latter is not available it should be stated that by "reduction time" is meant the time taken by 40 c.c. milk at 37° C. to reduce or decolorise a fixed quantity of a solution of the dye methylene blue. The reduction time is generally a rough measure of the numbers of bacteria present, a low reduction time indicating a high bacterial content. The fermentation test gives a rough indication of the nature of the bacterial contamination. The milk is kept for twenty-four hours at 37° C. From the type of curd formed a general idea can be obtained of the predominant type of bacteria present. The results are given here as numbers, No. 1 being best and No. 5 worst.

Experimental Work.—In the first series of experiments six cows were employed. Each cow was milked throughout the series by the same milker, but into a different pail on each of five successive days. Each pail was sterilised by steam immediately before use. The results are given in Table I.

So far as total bacterial count is concerned it will be observed that all the covered pails are very decidedly superior to the open one. The results for B, D and E are practically equal: that for C is rather higher. In the reductase test the covered pails give approximately equal results: the open pail is decidedly inferior. The results of the fermentation test indicate that B is distinctly superior to all the others.

In Table I. many of the individual results are not in complete agreement with the averages. This was to be expected in such tests, as the condition of cows, byre, etc., with regard to cleanliness necessarily varies from day to day. An attempt was, therefore, made to eliminate some of these causes of irregularity in the second series of experiments. Here ten cows, each giving a large quantity of milk, were selected. All the cows were milked by the same milker throughout, but at each milking approximately equal quantities of milk were milked into each of the five pails in turn. In order to eliminate the effects of the difference in bacterial content of the first and last milk, the fore-milk from each teat was rejected and the order of milking into the pail was varied from cow to cow as follows:—

TABLE I.

Cow No.	Bacteria per c.c.					Reduced in (hrs).					Fermentation Test.				
	A.	B.	C.	D.	E.	A.	B.	C.	D.	E.	A.	B.	C.	D.	E.
1	34,400	3,600	37,200	3,100	1,650	13½	17	15	16¼	15¾	4	2	3	4	4
2	9,000	1,300	3,900	1,900	2,600	14¾	17	17¼	14¼	13¼	5	1	4	4	5
3	4,000	5,600	1,650	2,200	5,500	14¾	12¾	20	16½	15	4	2	5	4	3
4	17,600	3,300	7,000	1,550	7,300	12½	15	12½	17½	15¼	4	4	5	3	4
5	6,200	10,200	2,000	16,200	2,300	14¼	17	16¼	14	19¼	2	4	3	3	2
6	4,500	3,400	1,050	3,500	5,300	16½	18	19	17¼	20¼	2	2	3	2	2
Average.	12,600	4,600	8,800	4,700	4,100	14½	16	16¾	16	16½	3·5	2·5	3·8	3·3	3·3

Cow 1. Order of milking, A, B, C, D, E.
Cow 2. „ B, C, D, E, A.
Cow 3. „ C, D, E, A, B., etc.

The pails were sterilised by steam immediately before use. Table II. gives the results:

TABLE II.

Cow No.	Bacteria per c. c.					Reduced in (hrs).					Fermentation Test.				
	A.	B.	C.	D.	E.	A.	B.	C.	D.	E.	A.	B.	C.	D.	E.
1	16,500	900	300	400	250	20¼	23½	27	23	23½	4	3	1	1	1
2	1,350	200	300	300	350	19½	26½	25	25	24½	4	1	1	1	1
3	1,000	900	100	650	350	16	16¾	17½	16½	18	5	5	1	1	5
4	2,100	200	650	500	100	19½	24½	24	19½	24	4	4	4	4	4
5	8,050	500	550	3,700	300	13	16	15	15	25½	4	1	1	4	1
6	23,700	9,700	20,200	5,700	6,000	16	18½	16	19	20	5	4	5	4	4
7	33,300	1,300	500	550	700	18	25½	24	25½	27	4	4	1	4	4
8	3,300	4,300	2,450	1,050	150	21	18½	21	24	24½	4	4	3	4	5
9	18,200	2,950	450	...	400	14½	13½	19¼	...	24½	2	5	1	...	2
10	37,700	1,050	1,000	3,000	800	17	19¾	24¼	19	17¾	4	5	3	2	3
Average.	14,520	2,200	2,650	1,760	940	17½	20¼	21¼	20¾	23	4·0	3·6	2·1	2·8	3·0

The figures in Table II. are, in a general way, confirmatory of those in Table I. Particularly, it is interesting to note that the order, so far as bacterial content is concerned, is the same as in the first series. But the differences are more marked, and pail E gives a much lower bacterial content than any of the others. The latter result is supported by the figures obtained in the reductase test.

On several occasions determinations of the number of lactose-fermenting organisms (bacteria mainly derived from contamination with manure) were made in these samples. But they were never found to be present in large numbers—always fewer than 1 per c.c.. The results have, therefore, been omitted from this paper.

The figures given in Tables I. and II. would seem to warrant the following conclusions :—

(1) The covered pails tested, as compared with the open pail, have effected a considerable reduction in bacterial content of milk. This reduction varies from about 63 to 94 per cent. on the average when pail C is omitted.

(2) The use of a single metal strainer in C as compared with B —the same pail without the strainer—has resulted in an increased bacterial content in the milk. This is no doubt due to the breaking up of dirt particles and clumps of bacteria on the strainer by the subsequent milking and the washing of the smaller particles, bacteria, etc., through the sieve by the milk. A single metal strainer would, therefore, appear to be quite ineffective in reducing the bacterial content of milk drawn directly into it. Pail C has, therefore, been discarded in the subsequent tests.

(3) Pail E, with metal and cotton strainers, has proved most effective under the conditions of these experiments.

In the foregoing series of tests the conditions were not quite such as would obtain in ordinary practice, as the pails were sterilised before the milking of each cow. From the point of view of obtaining an absolutely fair trial under practical conditions this ought not to make a great difference in the results so far as A, B and D are concerned. But in the case of the pails with strainers one would naturally expect that the sediment would gradually accumulate on the strainer surface during the course of a milking and that this accumulation would be washed by the milk drawn subsequently. As a result, if the pails were sterilised only at the beginning of the milking, as is usually done in practice, and not before the milking of each individual cow, it might happen that the milk reaching the pail in the later stages of a milking would be more highly contaminated than that of the first few cows.

The third series of tests was, therefore, devised to represent more closely conditions such as obtain in practice. Five lots, each of six cows, were selected, and each lot was milked throughout the experiment by the same milker, using different pails on successive days. The pails were thoroughly sterilised by steam before each milking, but not again during that milking. The milk obtained from each lot of cows was collected in a steam-sterilised ten-gallon railway churn. It was thoroughly mixed by means of a metal plunger which had been sterilised by steam, and samples were taken and examined in the usual way. The work was carried out at a different dairy from that at which Series 1 and 2 were conducted.

Table III. gives the results:

TABLE III.

Lot No.	Bacteria per. c. c.				Reduced in (hrs).				Fermentation Test.				Lactose Fermenters p. c.c.			
	A.	B.	D.	E.	A.	B.	D.	E.	A.	B.	D	E.	A.	B.	D.	E.
1	37,000	8,200	8,700	7,400	11	12¼	14½	15	4	1	1	1	5	5	...	10
2	7,300	4,150	17,100	6,500	15¼	16¾	12¾	12¼	5	1	3	5	...	...	10	5
3	65,600	16,450	6,900	14,900	13	15¾	17½	16¾	5	1	1	4	10	...	...	...
4	17,500	7,400	6,400	5,300	16	12½	14¼	17	3	1	1	1	50	5	...	1
5	7,000	11,750	13,300	10,500	13	15¾	13¼	14	3	3	3	3	5	5	50	...
Average.	26,880	9,590	10,480	8,920	13¾	14½	14½	15	4·0	1·4	1·8	2·8	14·0	3·0	12·0	3·2

... = lactose fermenters absent from 1 c.c.

Here again the superiority of the covered over the open pail is clearly brought out. The reduction in bacterial numbers, while not so marked as in the former cases, is still considerable, and amounts to, roughly, 60 to 70 per cent. And the results of the reductase and fermentation tests and counts of lactose fermenters generally support the bacterial content figures.

Comparative Values of the Different Pails.—When the results from the individual covered pails are considered they are seen to be practically equal; no one covered pail gives results decidedly better than the others. This is particularly interesting in view of the marked superiority of E as shown in Table II. From these results it would appear that pail E will yield cleaner milk than any of the others when it is cleaned and sterilised before the milking of each cow. But where cleaning and sterilisation are carried out only once, at the beginning of the milking, the results obtained are practically equal to those got with pails B and D.

The milk from the covered pails always contains less sediment than that from the open pail. Pail E gives milk with less sediment than any of the others. This last result, at the first glance, may appear contradictory to the bacteriological findings. But in reality it is not so. Removal of dirt from milk does not necessarily mean removal of the bacteria associated with it. A strainer which removes the greater part of the sediment from milk will allow most of the bacteria to pass, owing to the fact that the latter are exceedingly minute. In fact, only those bacteria which adhere to dirt particles are removed by the strainer. The longer the sediment is allowed to soak in the milk the softer it becomes and the greater the number of bacteria which escape from the dirt particles into the surrounding fluid. This almost certainly accounts for the fact that in the third series of tests, where the pails were used throughout the whole milking without being sterilised, pail E gives results which are not markedly superior to the other covered pails. During milking the sediment accumulated on the strainer and was being continually washed and softened by the milk passing through.

It now becomes necessary to consider one or two points in the construction and use of the covered pails. In the first place it is fairly obvious that a covered pail, to be effective in practice, must be reasonably easy to milk into. If it is too difficult it generally defeats its own purpose. This was well illustrated during the course of this investigation in the case of pail D. Here the opening of the pail is oval and when the latter is in position for milking the mouth of the pail is vertical. Consequently this pail is somewhat difficult to milk into without losing a certain amount of milk. Careful milkers could use it fairly easily, but the majority had difficulty in milking into it. The result was that on several occasions milkers were found using the pail with the opening horizontal instead of vertical. This, of course, to a great extent does away with the advantage of the pail, because it enormously increases the area of opening exposed to falling dirt particles. Thus pail D, owing to the fact that in the normal position it is difficult to milk into, tends to defeat its own purpose when placed in the hands of a careless or thoughtless milker.

In the case of a covered pail, owing to the small size of the opening, the height of the pail is a much more important point with regard to convenience in use than it is in the ordinary type With the ordinary wide-mouthed pail it is generally possible, by slight tilting, to get at least a small portion of the opening of the pail under the udder of even the most short-legged cow. Where the area of the opening is restricted, however, this is frequently impossible. Pail D is particularly inconvenient in this respect. With short-legged animals it is practically impossible to milk into this pail when it is held in the normal position. Pail B is also rather inconvenient, but the fact that the mouth of the pail is sloping and not vertical allows of its use in cases where D is excluded. Pail E is very convenient.

But the height difficulty in the covered pail of type B or D is not an insuperable one. The pails could quite easily be made considerably lower and the required capacity could be obtained by increasing the diameter. A pail of oval cross-section would be most convenient to use, the shorter diameter being held between the knees during milking.

In the milking of newly calved cows the covered pail is most difficult to use satisfactorily. This is due to the enlargement and hardness of the udder. As a consequence the teats are wide apart and it is very difficult to direct the milk from the quarters on the far side into the narrow opening of a covered pail, owing to the hardness of the udder. But, as a rule, the hardness becomes very much reduced after the first week and, as during this period the milk is not generally used for human consumption, this drawback to the use of the covered pail is considerably minimised in importance.

Where a strainer is used it is important to have it at least two to three inches below the lip of the pail to avoid loss of milk by spurting during milking. Pail E is sometimes troublesome in this respect—especially in the milking of cows with wide teat ducts where the milk jet is heavy. The capacity of this pail, too, is rather small. When dealing with heavy milkers the milk frequently fills the pail to such an extent that the cotton strainer becomes saturated with milk. A considerable loss of milk is then liable to occur when the lid is removed for the purpose of emptying the pail unless special precautions are taken. The pail has the further disadvantage that the lid carrying the strainer is completely detachable and so the strainer is liable to become contaminated by thoughtless milkers resting it on a dirty floor, etc.

Conclusion.—The results of this inquiry may be summarised as follows:—

(1) By the use of covered milking pails a reduction of from 63 to 94 per cent. in the bacterial content of milk was effected as compared with the usual method of milking into open pails.

(2) The use of a strainer in the neck of the pail is of no advantage unless it is carefully sterilised after the milking of each cow—a precaution which is not generally practicable. Even when the latter precaution was taken it was found that a single metal strainer was rather a disadvantage than otherwise. To be effective the strainer must contain at least one layer of cotton filtering material. The difficulty of sterilisation might be overcome by the use of discs of cotton wool such as are used in many of the modern milk strainers, a fresh disc being used for each cow. Where a strainer is used it should be at least two to three inches below the lip of the pail and should be of such a type that it cannot be completely detached from the latter.

(3) The main essentials in the construction of a covered milking pail are:

(*a*) It must be large enough to hold the whole of the milk of the best cow in the herd.

(*b*) It must be fairly easy to milk into.

(*c*) It must not be too high.

A pail of type B, reduced in height to about 15 inches to the top of the opening and correspondingly widened, would meet these requirements.

I wish to express my thanks to the Edinburgh District Lunacy Board and to Mr Robertson for having placed their herds at Bangour and at Damhead, Gorgie, respectively, at my disposal for the purposes of this investigation. I also wish to thank Professor Cossar Ewart for the loan of pails D and E.

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SCOTTISH PURE-BRED LIVE STOCK.

X.—CHEVIOT SHEEP.

JOHN ROBSON, *Secretary, Cheviot Sheep Society.*

SIR JOHN SINCLAIR and his friends were the first to discover the merits of the native sheep of the Cheviot Hills and were probably also the first to give the breed the name Cheviot which they still bear.

In January 1791[1] he, with several friends, founded what they called the British Wool Society. The principal object of this Society was to find out what were the best sheep to improve the native sheep of Scotland. With this object in view they sent Mr Andrew Kerr, a Border Sheep farmer, to make a report on the sheep of the East and North of Scotland. Acting on his advice they bought fifty rams and 100 ewes to distribute all over the Northern part of the Kingdom, beginning in Perthshire and going on to Caithness. This flock was placed in small numbers with about thirty farmers, twelve rams and twenty-one ewes reaching Caithness. The cost of driving them from the borders, including maintenance, tolls and ferries was 1/1¾d. per head. Another flock was purchased for farmers in the neighbourhood of Edinburgh and Glasgow.

The resulting demand from Scotland put the price up to a guinea per head. After this several farmers left the Borders for Sutherland and Caithness taking their flocks with them, and by so doing turned much unproductive land to a good use, though they also in too many cases supplanted the crofters.

At that time the Cheviot bore but a distant likeness to the present-day type. Generations of careful selection have evolved a much more beautiful animal, as a glance at the photos will show. Then it grew a short fleece of fine wool mixed with fine white hairs very much the same as that of the unimproved Welsh Sheep of to-day. The fleece would weigh no more than 2 lbs. and was very liable to be cast if the sheep got at all lean. The wedders weighed about 50 lbs. The Robsons of Belford were the first to improve the quantity and quality of the fleece; whether they did so by natural selection or by going South for heavier coated rams is uncertain, but they succeeded; their sheep were greatly run after, and wherever used they did an immense deal of good.

Even fifty years ago however there was still a great deal of "kemp" or hair in the fleece, but this has been entirely bred out, and the Cheviot wool of to-day is of much more equal quality than that of former times. At the same time it is probable that the improvement of the fleece has been at the expense of the milking properties, for certainly the bare-bellied ewes of olden days were the best nurses.

About 1870 the Cheviot sheep was at the height of its fame,

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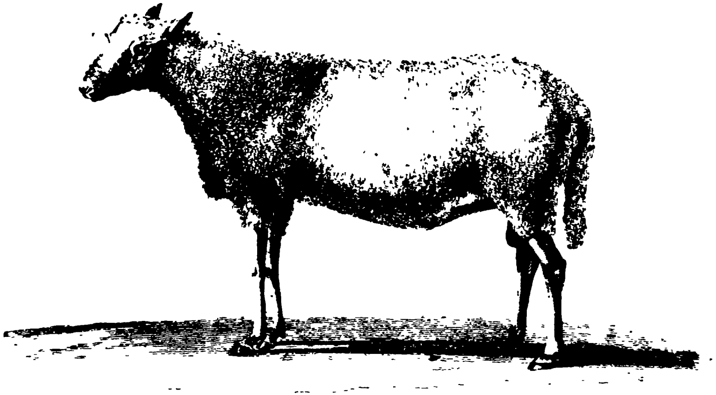
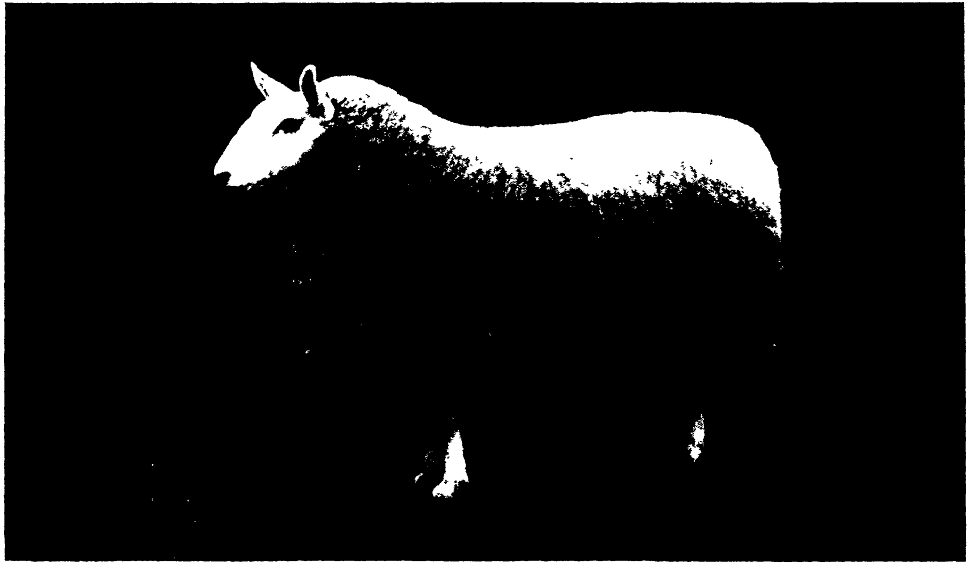
[1] See *General View of the Agriculture of Midlothian*, by George Robertson, published in 1795.



Cheviot Ram in 1794.

Reproduced from Messrs Bailey & Culley's Survey of Agriculture in Northumberland, 1795.

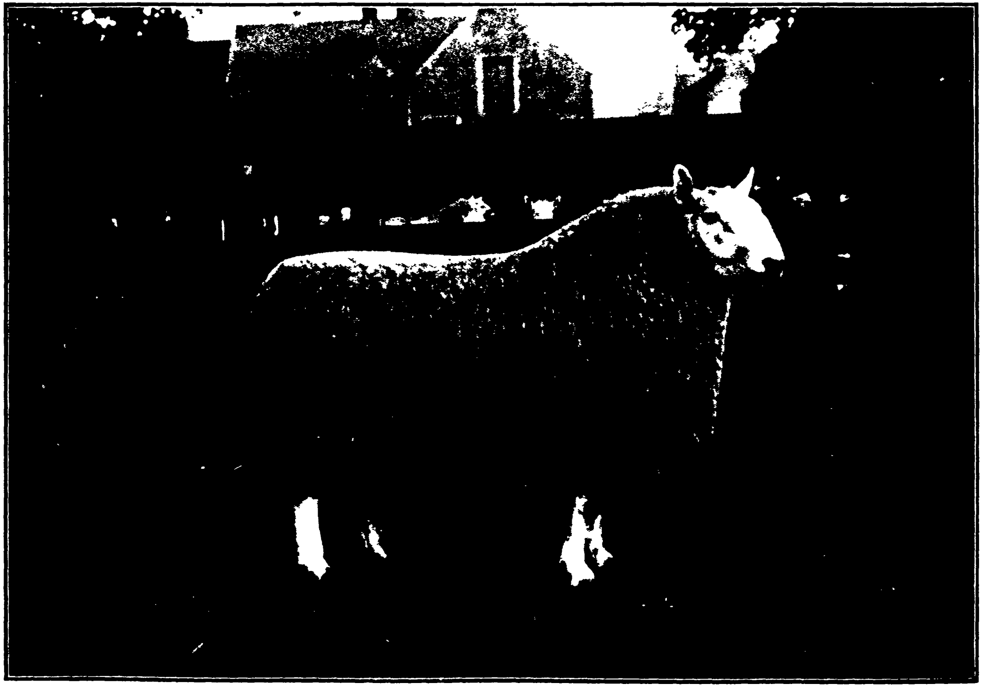
(Reproduced by kind permission of Messrs R. Deans & Co., Hawick.)



Cheviot Gimmer, LADY LIVERPOOL.

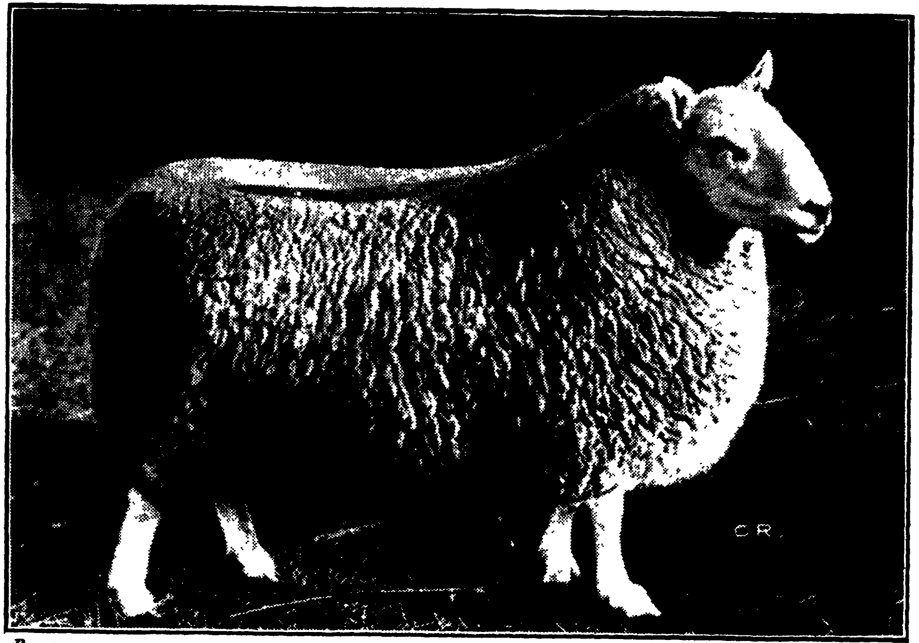
First in Class and Champion Cheviot at Highland Show at Dumfries, 1910.

(Reproduced by kind permission of Messrs R. Deans & Co. Hawick.)



Cheviot Ram, Attonburn Style.

(Reproduced by kind permission of Messrs R. Deans & Co., Hawick.)



Reid] *[Wishaw.*

The £1200 Cheviot Dinmont, DIGNITY

First in Class and Winner of President's Medal for best animal of the Cheviot Breed at the Highland and Agricultural Society's Show, Aberdeen, 1920.

(Reproduced by kind permission of the "North British Agriculturist.")

stocking as it did the whole of the Borders from the Irish Channel to the North Sea, as well as all the North of Scotland and much of the West also. The severe winters of the eighties, however, combined with the disastrous fall in the price of wool and the diminished popularity of wedder mutton caused a reaction, and the Blackface Sheep took its place after these bad winters on much of the harder ground. But on all land for which it is adapted it more than holds its own, and while it can safely claim to be the aristocrat of the ovine race, it is also one of the most useful.

Many qualities combined to make the Cheviot Sheep of widespread importance and general utility. Its wool enables the Border manufacturers to turn out their tweed cloth, which is famous the world over. Its mutton is, if not the best, as good as the best, beating all but the Southdown in price, and when shown either pure or crossed being unbeatable in any carcase competition. When crossed with the Border Leicester, it produced the Half-Bred sheep which made the improvement of much of the South of Scotland not only possible but a profitable proposition.

Cheviots are wonderfully adaptable on suitable herbage—they prefer grass to heather, and if this is mixed with mossing so much the better. They thrive on the highest hills. When treated more kindly they respond at once, and given the same food are very little behind Half-breds in fecundity and mutton-producing capacity, while their wool is much more valuable. They stand cold and snow as well as, if not better than, any other sheep, their denser coats and bare legs enabling them to travel in deeper snow than other mountain breeds. They are great favourites and are daily becoming more popular in the United States and Canada. In South America and the Falkland Islands they are in demand for crossing purposes. In Norway and Sweden they are greatly sought after, and nothing but the cost of importation stands in the way of a great demand from all these countries.

On their native hills they are practically self-supporting, never being hand-fed except during severe snowstorms, when the snow lies so deep that they cannot reach the grass or heather: they are then given a little hay, about 14 lb. to the score being laid out in sheltered places for them, but this is withdrawn as soon as the snow goes. One shepherd looks after five or six hundred sheep, getting assistance for one month in lambing time. The tups are put out about the 21st of November bringing the lambing in about 16th April. Sixty ewes are allowed to each tup. The best ewes are usually taken out and put to a favourite tup, and from these the tup lambs are selected, the rest being castrated when about a month old. Clipping comes on in July, and if the wool is sold washed, the sheep are made to swim a few times through a pool of water a week previously. Then in August the wedder lambs and those ewe lambs not required to keep up the stock are sold. In October the draft ewes are sold, at either five or six years old, as the custom is, and after that dipping and marking complete the year's routine.

On their hill pastures from one to three acres according to the ground are required for each sheep, so each shepherd has on an average one thousand acres on his hirsel. Formerly the tups were sold privately at the Tup Fair at Hawick, but in 1861, the late Mr James Oliver began to sell them by auction and now they are practically all disposed of in that fashion, Hawick, Lockerbie and Lairg being the principal marts where they are exposed.

The following, taken from an article by Mr David Archibald in the transactions of the Highland and Agricultural Society, Vol. xii. written in 1880, compares with present prices. "The highest figure that has hitherto been brought by a Cheviot Tup, it should be stated, is 185 guineas, for this sum the Kinnelhead ram "Craigphadrig," the first prize tup at the the Highland Society's Show at Inverness in 1865, was sold at Beattock Sale in 1867. Mr Brydon has also the credit of having obtained the highest average price ever quoted at a Tup Sale, having in 1865 reached £14 14s. Next to this figure the largest average realised at any Sale has been £12 10s., which Mr Archibald's "Glengelt" lot made in 1875 at Hawick."

Since those days prices have taken a great jump. In 1915 Miss Grieve of Shelfhill sold a tup at Hawick for £225, the "Millknowe" average on that occasion being £26 9s. In 1917, Newlands averaged £43 10s. 9d., ten lots making an average of over £20. The next year saw another advance, Flemington averaging £47 17s. 6d. and Hindhope £46 17s., with twenty-one lots over £20. But these prices were easily eclipsed in 1919, when fifteen tups from Millknowe averaged £111 11s. 4d. with a top of £620. This was again beaten in 1920 when seventeen from Blackhaugh averaged £136 8s. 2d., the top on this occasion being £1,200, a record that will likely stand.

The price of wool has suffered many fluctuations. In 1872 it touched 24d. In 1901 it fell as low as 5½d. During the war, wool prices were controlled but as soon as control was taken off it rose to 43d. per pound, to fall in 1921 to below 10d.

The following description of a Cheviot sheep is based on the article in the Flock Book of the Cheviot Sheep Society founded in 1893:—

"A Cheviot tup when arrived at maturity weighs when fat at least 200 lb. live weight. He should have a lively carriage, bright eyes and plenty of action. His head medium length, broad between the eyes, should be well covered with short fine white hair. His ears nicely rounded and not too long should rise erect from the head—low set or drooping ones are a decided fault. But at the same time they should not be what are called "hair lugged," that is, too near each other, as that indicates a narrow face which generally denotes a narrow body. His nose and nostrils must be black, full and wide open, his neck strong and not too long, his breast broad and open with the legs set well apart. His ribs must be well sprung and carried well back towards the hook bones, as a long weak back is about the worst fault a Cheviot can have. His back must be broad and well covered with mutton, his hind quarters, full straight and square, the tail well hung and nicely fringed with wool. His legs must stand squarely from the body (the hocks being bent neither out nor in, the latter especially being regarded as a weakness). The bone must be strong, broad, and flat, and all covered with hard white hair. He ought to grow a fleece weighing from 10 to 12 lb. of fairly fine wool densely grown and of equal quality; coarseness on the buttocks is a decided blemish. The wool should meet the hair at the ears and cheeks in a decided ruffle, bareness there or at the throat being inadmissible, and it should grow nicely down to the hocks and knees. The belly and breast ought also to be well covered. The same description when modified applies to ewes also, which will weigh from 100 to 150 lb.

Cheviots when in a natural state grow fine wool; hand feeding tends to make it stronger, but it must be stiff and dense, and not too short. A hill flock should clip on the average 4½ lb. per sheep, but if wedders are kept that weight will be increased. A lot of draft ewes moderately fat will weigh from 95 to 100 lb., and old wedders 100 lb. live weight. It must always be remembered that Cheviots must combine hardihood with feeding properties for they are expected on their native hills to stand great privations in hard winters and backward springs. If once they are bred too soft to stand the natural conditions on their own ground, they either die off, or their owners have to incur great expense in taking grass parks or buying artificial food.

The perfect Cheviot is one which will live and thrive well on the hardest keep, and when taken to lower and better ground will prove itself equal to the occasion by growing larger and becoming fat."

A CONTRIBUTION TO THE STUDY OF JOINT-ILL IN ANIMALS.[1]

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The investigation to be described below was begun in the spring of 1917, was intermitted for two years, and resumed again in the springs of 1920 and 1921. In 1917 considerable interest was being shown in the subject of Joint-Ill in foals, and it was in view of this interest that work on the subject was commenced. It seemed, however, that such work could be better carried out in sheep for the following amongst other reasons. Not only is the number of sheep in the country greater, and the individual sheep of less value, and, therefore, more easily obtained, but sheep are associated together in much larger numbers than can ever be the case with horses. It is not uncommon to have flocks on low ground farms of anything from 500 up to 1500 breeding ewes. Facts regarding

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the disease would, therefore, it was thought, stand out in greater relief, while apart from this the relation of the disease to multiple births, and to the practice of "twinning-on" along with other usages peculiar to sheep husbandry would also be observed. The conclusions arrived at, while bearing directly on this important disease of sheep would also be available for a consideration of the disease in the horse and other animals.

Before entering into a discussion of the investigation, a few points may be noted regarding the historical aspect of the subject. These, fortunately, can be dealt with briefly owing to the existence of recent papers on the subject by Brown (1); Magnusson (2); M'Fadyean and Edwards (3) and (4); Edwards (5). Adsersen (6), De Blieck (7) and others have also discussed the subject more particularly from the bacteriological point of view. In carrying out this purpose I shall follow more or less the lines laid down by Magnusson and by Edwards in their critical survey of the subject mentioned above.

It would appear that Joint-Ill in foals may be divided into two groups, a more chronic group caused by Streptococci and one much more acute, occurring much earlier in the life of the foal due to such organisms as *B. nephritidis equi* (*B. viscosum equi of Magnusson, B. pyosepticus equi of De Blieck*), Coliform organisms and miscellaneous organisms of which the chief would appear to be *B. abortivo equinus.* As regards causation percentage, Streptococci would appear to be responsible for about 50 per cent. of the cases, *B. nephritidis equi* for about 21 per cent., *B. coli communis* for 21 per cent., and miscellaneous organisms (especially *B. abortivo equinus*) for 8 per cent. According to those who have investigated the matter, the Coliform organism found differed from a type strain of *B. coli*, and probably differed among themselves. *B. abortivo equinus* would appear to be the only one that gains entrance to the foal's body prenatally, and where this organism is found in cases of Joint-Ill, it would appear that cases of infectious abortion have occurred among the mares in the stud from which the foals were obtained.

With regard to the question as to how the infection is produced in the foals, Magnusson gives a summary of the reasons for the existing impression that the foal may be affected before birth. Among these are the following:—(*a*) there are certain ill-fated mares which, year after year, give birth to foals that perish from Joint-Ill; (*b*) the disease often appears in foals so early that a post-natal infection could not have had time to develop; (*c*) even when the navel wound has been treated with great care, Joint-Ill has nevertheless set in.

With regard to (*a*) Magnusson points out that, on the other hand, mares may harbour in their intestines a virus of very high virulence, and thus act as carriers of the disease. Again, if infection were contracted *in utero*, it would be necessary to admit that mares are frequently the subject of mild or chronic endometritis. This, according to Magnusson, is not true, for mares are rarely subject to this condition, and if it did actually occur, it is more than probable that abortion would ensue; and as mentioned above, only a small percentage of the cases of Joint-Ill are associated with abortion in mares. With regard to (*b*) in no case has a foal yet been discovered at birth with any developed lesions such as abscesses or arthritis. Infection with subsequent death in a new born foal has, however, always been a septicæmia and Adsersen and Magnusson have shown that there are species of Joint-Ill bacteria capable of causing symptoms, and even death, within twenty-four hours under favourable conditions. It is, therefore, not necessary to invoke intra-uterine infection to explain the early deaths of the foals. With regard to (*c*) it would appear that the navel wounds of foals as distinguished from other animals are very easy to infect, and the opinion is expressed that navel infection is responsible for a large proportion of the cases of Joint-Ill in foals. It is not suggested, however, that the navel wound affords a port of entry for infection in every case of Joint-ill. Cases undoubtedly occur in which the virus enters by the intestine as it does commonly in calf infections. This latter remark refers particularly to cases in the foal caused by *B. coli* infections, for as Magnusson states these often appear as a severe enteritis with an attendant Bacteriæmia. There are, of course, also the small percentage of cases caused by *B. abortivo equinus*, where the infection as previously stated is in all probability intra-uterine.

With regard to treatment, it is stated in the papers quoted that, as regards both preventive and curative treatment, the methods which have held out the greatest promise of success are those involving the use of specific antisera and vaccines. It is pointed out, however, that before one can estimate the value of any curative treatment, the indispensable preliminary is to have some knowledge as to what is the normal death rate in untreated cases. M'Fadyean and Edwards estimate this, from some of their experimental work, at 50 per cent. In order to demonstrate, therefore, that serum or vaccine does exercise an ameliorative effect, it must be shown that it is capable of lowering the mortality quite appreciably below 50 per cent, when tested on a sufficiently large number of cases in many different localities and over a sufficiently long period of years to obviate any chance of statistical error. M'Fadyean and Edwards using this standard came to the conclusion that the anti-streptococcus serum used by them in 1919, had no effect on the death rate.

Magnusson dealing with this question, after undertaking trials of serum and vaccine treatment of Joint-ill, expresses the opinion that the prospect of successfully treating foals already infected, and showing such highly developed lesions as severe arthritis with outward fistulæ, etc., is practically nil. He states, further, that it is useless to treat cases infected with *B. nephritidis equi*, with the specific anti-serum for this serum fails to act even preventively. Magnusson would, however, appear to hold the view that anti-streptococcic and anti-coli sera in large doses are useful in early cases of the disease. Edwards, however, criticises this latter statement of Magnusson. He points out that the evidence to hand points decidedly to the uselessness of serum treatment in declared cases of Joint-Ill. He adds that even if the large doses recommended by Magnusson were of any use, they could only be expected to exercise an effect on about 50 per cent. of total cases, and the effects would be appreciable only in the milder of these cases. He points out that the difficulty could not very well be avoided by the use of Polyvalent[1] serum purporting to be specific against the whole group of Joint-Ill organisms, for in general, such a serum unless given in very large doses would be weak against every member of the group.

As regards preventive treatment Adsersen tried the inoculation of foals with an anti-streptococcus serum without, however, any good resulting. Magnusson tried the simultaneous use of a streptococcus vaccine, and an anti-streptococcus serum, also as a preventive on foals. He claims good results for this method, but Edwards is sceptical regarding any benefit. While summing up this part of the subject M'Fadyean and Edwards state, that in view of the failure of curative treatment with anti-streptococcus serum, the value of this serum as a prophylactic ought to be regarded with a certain degree of distrust, for as yet there is no definite evidence as to the natural case mortality in Joint-Ill. It is, therefore, difficult to judge of the value of any prophylactic agent.

Edwards further discusses the attempt to protect the foal by immunisation of the dam before the foal is born. According to him there would appear to be no statistics extant by which the value of this procedure could be assessed. With regard to the Forsell method of treating the foal by injection of large quantities of its mother's serum, German investigators would appear to regard it favourably. Magnusson, however, discussing this point states that the good results claimed for its use in Germany, do not always stand the test of close inspection.

In concluding his discussion of the treatment of the disease, Edwards expresses the opinion that in the present state of our knowledge, there is yet no justification for abandoning the care of the navel, a method of prevention, the value of which has been firmly established by a prolonged and varied experience. Serum and vaccinal methods of dealing with the disease would appear to be of no avail.

Having introduced the reader to the salient facts of the disease as it occurs in horses, I shall now proceed to describe my experiences of it in sheep. The first outbreak occurred in a flock of about 1,300 half-bred ewes on a low ground arable farm. After the tupping of the ewes was over, the season being a very open one with considerable growth of grass, the ewes were kept on this grass (moorland pasture) up to the beginning of January. Thereafter, as the turnips were very plentiful, and as there seemed to be no way of getting rid of them, except by eating them off by the breeding ewes, all these ewes with the exception of about 120 were folded closely on the turnips, and were kept there constantly without any change till they began to be drawn in at the end of February into the lambing fields. While they were on the turnips, they received nothing but the turnips. Quite a different treatment was meted out, however, to the remaining 120. They were put on to grass fields of much better quality than those on which they had been previously, and were in addition box fed. The different treatment the two lots received is reflected in their subsequent history, which will be dealt with later. It may be mentioned, however, that the owner of the sheep was quite aware of the danger he was running, but the exigencies of the case decided him to risk it. Feeding breeding ewes on turnips alone, especially Swedes, is recognised to be bad practice. Matters were aggravated somewhat in this case by the fact that owing to the growing season, the turnips began to shoot and became fibrous and stringy. Moreover, the turnips were on moorland which had hardly at all been improved.

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[1] A serum produced by immunising an animal with all the varieties of organisms believed to be causal of the disease.

Lambing began about the end of February with the older ewes. As the ewes became due to lamb, they were drafted in lots into the lambing shed field. The greatest care was taken in the routine of lambing, and the lambing was carried on as in other years. The lambing sheds, which had been used in previous years, were well constructed and had been very thoroughly cleaned out prior to the commencement of lambing. The shepherds understood the use of disinfectants for their hands—lysol was used—kept their nails short, and interfered as little as possible with the process of lambing. As a matter of fact there was less manual interference this year with the lambing as there were fewer bad cases requiring such. The ewes lambed in the field during the day and in the enclosure of the lambing shed at night. Ewes and lambs were kept in separate small roofed-in enclosures (paddocks) surrounding the lambing-shed for two nights subsequent to lambing. Thereafter, they were sent out to the fields to make room for others coming in. Cleanings from the ewes were at once disposed of so that none were left to pollute the place, and on the removal of a ewe and lamb from the paddock to the fields, fresh straw in abundance was placed in the paddock before it was occupied again.[1]

Joint-Ill began among the lambs of the old ewes brought in at the end of February, when these lambs were a week old, and when the gimmers were brought in about the end of March, the disease similarly began in them. In all abont 150 lambs died, or were killed because of the disease. It has to be noted, however, that there was no case of the disease among the lambs of the 120 ewes, composed of all ages which had been kept on grass and box-fed, although these lambed at all periods of the lambing season. The cases all occurred in the lambs from the turnip-fed ewes.

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[1] No attempt was made at "mucking out" the pens. If this procedure is carried out, there is the very greatest liability to "Black-leg" appearing among the lambs.

The routine of the lambing season differed in no way from that of other years, except that with advancing experience, the rules regarding cleanliness, etc., were more rigid than in other years, when there was no epidemic of Joint-Ill. On the other hand, as regards weather conditions, in the words of the shepherd, this was a grand lambing season. There was no rain and the pens were always dry. In other years, unaccompanied, however, by any outbreak of the Joint-Ill, the lambing shed has been a quagmire. The shepherd especially remarked one year, where in addition to the quagmire condition above mentioned, the lambing field was litterly covered with cow-dung, yet without any outbreak of Joint-Ill occurring, although the conditions usually supposed to be most favourable for its occurrence were present. A considerable number of navel-ill cases, however, occurred.

As regards the conditions of the turnip-fed ewes, when they were brought in for lambing, the shepherd volunteered the information that, though they looked as fat as in other years, they lacked spirit, were listless, and carried their lambs very heavy. He further volunteered the information that the lambs when born were this year a much poorer lot, much smaller and weaker than in an ordinary year. There was no evidence that the ewes suffered from any disease, infectious or otherwise, at any period prior to lambing.

In this flock it was a yearly occurrence to have four or five lambs—never more—affected with Joint-Ill. The increase this year was a "bolt from the blue," and had not been gradually worked up to over a number of years. It had also no relation to the buying in of new ewes, as the disease occurred first in the old ewes which had been on the farm for several years. At the same time the gimmers had been on the farm for at least a year and a half.

Two cases of "slipping the lamb" had occurred during the season. Such a happening occurred in other years, and the number of eild ewes was no greater this year than usual. There was thus no evidence of the presence of contagious abortion.

The disease had no relation to Udder Clap in the ewes, because Udder Clap has been rampant in other years without Joint-Ill being so. Besides, cases were observed where an Udder Clapped ewe was suckling a healthy lamb. There were no more cases of Udder Clap in the flock this year than usual.

"Rotten lambs" a condition where a ewe may give birth to one or more dead and disintegrated fœtuses occured more frequently this year than usual in the flock. "Rotten lambs," however, occur more or less every year without the concomitance of an increase of Joint-Ill, and cases were frequent this year where ewes lambed one or even two healthy lambs which never took Joint-Ill, and at the same time two or one "Rotten lambs." It would appear as if the two were not related to one another, except that both might have a common predisposing cause. In this instance the treatment of the ewes prior to lambing might be the predisposing cause.

As regards the occurrence of the disease in twins or triplets, the evidence obtained here seemed to show that all the members of the family were affected with the disease, if the disease appeared within the first few days after birth. If the disease appeared later the chances were that only individual members of the family took it. The disease occurred more commonly in twins and triplets than in singles. There was no case in this outbreak where "twinned-on" lambs died when fostered on a mother, whose lamb had already died of Joint-Ill, in spite of the fact that such "twinned-on" cases were little short of a hundred. Navel-Ill was conspicious by its absence. In spite of the number of cases of Joint-Ill, only one case of Navel-Ill was observed. On the other hand, in other years in the same flock, Navel-Ill had been very prevalent without Joint-Ill being present. There was no information to be obtained in this outbreak, as to whether tup lambs or ewe lambs were more often the victims.

With regard to the joints chiefly affected, it was remarked by the shepherd that the joints of the foot were more than usually the seat of the disease in this outbreak. No evidence could be adduced in support of the view that the practice of carrying the lambs by the forelegs, predisposed the joints of these limbs to the disease. As regards the age of the lambs when they became affected with the disease, this was from one to two days old to a fortnight. Cases occurred which gave the shepherd the impression that the lambs has been born with the disease already on them. Such lambs were born in a very weak condition and developed the disease outwardly within twenty-four hours. One symptom exhibited by the lambs before they were definitely noticed to be wrong in the joints was a distension of the abdomen—a "baggedness"—and this was observed in all the cases. In some a slight diarrhœa—milk scour—was observed.

The pathological condition found consisted of abscesses in the joints, liver and lungs of the younger cases, whilst in the older more chronic cases, usually the joints alone were affected. Cultures made from the joints of the older chronic cases gave practically always pure growths of a streptococcus, whilst from the lesions of the younger more acute cases, cultures of coliform organisms alone or mixed with streptococci were obtained.

The second outbreak of the disease occurred also in a low ground flock of about 500 ewes. The findings in it generally corroborated those of the outbreak just described, so that it will not be necessary to describe it in detail. As before, the technique and routine of the lambing were unexceptionable, and were of the same nature as just described. The lambing season as regards weather conditions was the best the shepherd had had for twelve years. There had never been any Joint-ill in the flock, with the exception of a few cases in the previous year. During the last two springs, the ewes had been treated somewhat differently from previously. Formerly they had for three weeks prior to lambing, been box-fed in the fields, but this had been discontinued for the last two years. The shepherd was definitely of the opinion that the ewes were not in the same condition at lambing time as they had been in previous years. In this connection it may be mentioned that a neighbouring farmer, who never gave his ewes box-feeding prior to lambing, and in whose flock the year previously, Joint-Ill was extremely prevalent adopted box-feeding in the following year with the result that he had not a single case of Joint-Ill that season.

The lambs which took the disease in a declared form were noticed for some time previously to have very distended and "bagged" abdomens, as if they had had an overdose of milk. Often the lambs were "down" in this condition, but as yet showed no signs of swellings of the joints. At the same time "white scour" was noticed to be very rife among the lambs, especially amongst those whose joints were, or became affected. Cases occurred where one of twins had Joint-Ill and scour, and the other scour alone.

The lambs first showed evidence of the disease from twenty-four to forty-eight hours after birth up to a fortnight. In all about 120 lambs died of the disease. The lambs affected with the disease in the chronic form were often in very good condition, fat and well-growing. This was more especially the case in single lambs. Where the sick lamb was one of twins, the mother often neglected it in favour of the healthier one.

The ewes never showed any signs of definite illness prior to or after lambing. Only one lamb was found to be suffering from navel-ill. The pathological and bacteriological findings were as in the last outbreak.

Although 120 lambs died from the disease in this outbreak, in the following year there were only three cases of the disease.

The disease occurred mostly in twins and triplets: out of 120 lambs dead, only three or four single lambs were affected. Another point to be noted in reference to this outbreak was that as regards numbers of lambs, this was the best lambing season the shepherd had ever had. Unfortunately, the occurrence of the Joint-Ill entirely obliterated this advantage. The existence, however, of this large lamb crop, may have had an important bearing on the outbreak of the disease by putting thus a relatively greater strain on the ewes during pregnancy.

As regards "twinning-on" of the lambs, the general result was as in the last outbreak described, but there was the case of a ewe where five or six lambs were twinned-on in succession and all died. The possible explanation of such an occurrence, depending as it does on the age of the lamb when twinned-on, etc., need not be gone into here; the broad fact remains that as a general rule twinning-on may be carried on with impunity.

The third outbreak more particularly observed occurred in a pedigreed flock of about seventy ewes on a low ground farm. The routine of the lambing practice could not be criticised. The ewes began to lamb in January, and they were in a very fat condition. At the same time they were rather poor milkers. A single case of Joint-Ill had occurred the previous year: this year there were eleven cases of the disease. Of ninety-seven lambs born three were dead born, and one was born wrynecked and died immediately. Although the lambs were being born regularly all the time, there were two definite outbursts of the disease on two definite dates, each outburst being associated with the exposure of the lambs outside in the fields to a cold piercing day.

As showing the possibly negligible importance of the navel as a route of infection, it may be mentioned that three new-born lambs were twinned on to ewes by means of skins taken from Joint-Ill lambs, which skins were smeared all over the inside with pus, which had escaped from the joints when the skins were being removed. Nevertheless, none of the three lambs took the disease.

No disease was noticed among the ewes prior to or after lambing. The lambs began to show the disease first at an age of from two days to two weeks. "Baggedness" and slight scour were observed in several cases. The disease occurred mostly in twins. Out of eleven cases, ten occurred in twins, and there was only one case where both twins took the disease. Of the eleven cases eight were tup lambs, and three were ewe lambs. In none of the cases was there any evidence of navel disease. It is a well-established fact that, with regard to all diseases and the withstanding of rough treatment, ewe lambs are much hardier than tup lambs. This in all probability accounts for the relatively greater frequency in the tups as just recorded. At any rate it cannot be explained by infection of the navel from the penis of the lamb for navel-ill was not present.

Information derived from other outbreaks of the disease inquired into may now be summarised. Reference has already been made to the fact that the disease may be practically non-existent in a flock for a considerable number of years, may then suddenly flare up for a single season, and die out again next season, and continue thus. A considerable number of additional instances of this occurrence were observed. The disease hardly ever is extinct in a flock. There are always one or two cases. If the disease were infectious in the ordinary sense, due to a special organism or to increased virulence of organisms normally present in the fœces of the sheep, the potentialities for infection are there every season, and accordingly the same extensive outbreaks should occur every year. Yet this does not happen. In the same connection it may be stated that no evidence was encountered incriminating the navel as at all a common avenue of entry for the disease.

In all the outbreaks examined, there was the association in the flock at the same time of gastro-intestinal disturbance. In some cases this amounted to nothing more than the "baggedness" above referred to, in other cases there was definite "white scour" and "milk sickness," while in other cases, the condition had gone on to "black scour," or dysentery. Naturally with the latter condition, as the lambs die in a day or two, the condition of the joints enabling the disease to be called Joint-Ill would not show up. It is only in the more chronic and less virulent conditions, that the joint lesions would have time to develop to noticeable proportions. I have already dealt with this white scour or dysentry in lambs (8) and have pointed out its association with organisms of the "hæmorrhagic-septicæmia-coli-intermediate-coli" group, and have also referred to the parallelism of this condition to the disease "white scour" or dysentery of calves regarding which more will be said later. A very commonly held view among shepherds and farmers may be mentioned here, however, as bearing on the possible intestinal origin of the disease. It is believed that whilst a lamb may be brought up wholly on cows' milk, success never attends the attempt to bring them up partly on cows' milk and partly on the mother. Such lambs always go wrong, most of them falling victims to white scour or Joint-Ill. When a lamb is brought up in this last way, the reason usually is that its mother is in a poor way, and the lamb is a poor one, ill-nourished, and of low resistance, and the administration of the foreign milk is quite sufficient to tip the balance. Such conditions do not hold with the lamb brought up wholly on cows' milk, for here the mother is out of the way, and has usually died of some accident, or of some condition quite compatible with giving birth to a strong healthy lamb.

Pathological and bacteriological findings in the disease in this extended investigation were, generally speaking, the same as those described above. In individual cases such organisms as staphylococcus and Bac ovisepticus, a diphtheroid bacillus, occasionally cropped up alone or mixed with streptococci and coliform bacilli. It was seen futher, that although the streptococci found in different cases in the same outbreak, might be the same in a considerable number of cases, nevertheless, other types did occur under such circumstances, and the type further could vary in different outbreaks. This means that the same type of streptococcus was not responsible for all the cases in one outbreak, nor for all the outbreaks.

In summarising the information derived from these outbreaks, it would seem that navel infection is hardly at all responsible for the occurrence of the disease, that there is no evidence for the disease being infectious in the ordinary sense, and that facts are not forthcoming to warrant the belief that the lamb is born with the disease. The only view that would seem to accord with the facts is that, owing to lowered resistance of the lamb, a gastro-intestinal disturbance is set up whereby organisms, normal inhabitants of the intestinal tract of the sheep, are enabled to invade the tissues, and so produce the disease. Such lowered resistance of the lamb can be brought about by occurrences during the pregnancy of the mother, or by circumstances affecting the lamb adversely during life such as exposure to cold, too much or too rich milk, etc. A short survey of the literature bearing on this aspect will now be undertaken to see if there are any further tacts in support of this hypothesis.

Brown (*loc. cit.*) in discussing the disease in horses, though upholding the pre-natal infection theory, quotes from his experience facts which can quite well support the theory advanced here. Thus he states that breed has a marked influence on the occurrence of the disease. Clydesdales and Shires are especially liable to it, whilst in Shetland ponies its occurrence is rare. In-breeding and line-breeding seem to have a predisposing influence, for in the Clydesdale breed, it is most marked in pure choicely bred foals. So prevalent is it at times in this breed, that certain breeders in a particular season have been unable to raise a single foal. The length of the period of gestation has also an influence. Foals carried two to three weeks over their time are less frequently affected. Penberthy is quoted as having first pointed out that subjects of Polyarthritis are frequently born before the end of the normal period of gestation. Brown entirely agrees with Penberthy on this point as well as with his statement, that these are often weakly at birth and succumb in a few days. Peggie's observations (9) deserve mention in this connection. He treated sixty in-foal mares with a polyvalent anti-streptococcus serum, and during the whole season not a single case was observed in the foals of the mares which had received the injection. Every mare carried her foal a fortnight, and in many cases three weeks past her actual foaling period. The foals were born strong with a thick coating of hair, and in most cases the umbilical cord ruptured naturally, and did not require to be ligatured.' It might be thought that the anti-streptococcus serum was responsible for this good result. It is sufficient, however, to say here that this has not been proved, and that this result (leaving out of consideration for the moment the fact that other organisms besides the streptococcus cause the disease) is in marked discord with the observations of other investigators who have used anti-streptococcus serum. It is hardly likely either, that the injection of the serum would prolong the pregnancy which is the point in question. Brown goes on to state that the malady is very frequently met with in foals whose dams have suffered from such conditions as Influenza and Strangles before parturition. (This need not necessarily mean a pre-natal infection as Brown would appear to suggest, but only a weakening of the foal and its resistance.) He mentions, further, the fact that certain mares kept under the best hygienic conditions, habitually give birth to foals which die of Polyarthritis, and such foals may or may not be sired by the same stallion. He states that the stallion too is not above suspicion, although up to the present, he has not been proved to be directly responsible in any specific case. He remembers, however, an instance where fifteen foals sired by one district stallion died in one season, and the total number of foals left by him that season would have been sixty. Two of the cases occurred at a farm where the disease was unknown before, and both mares have since produced healthy foals. Both the affected foals died under three days. Such facts as these support as well the view put forward here, as they do Brown's pre-natal infection theory.

An instance will now be given of disaster to lambs through faulty treatment of the ewes during pregnancy. The disease described below, it may be mentioned in passing, would seem to have many points of resemblance to Joint-Ill. Gamgee (10), (p. 331), quotes from a description by a Mr Randall in the *Albany Country Gentleman* in the State of New York of a severe disease in lambs in the spring of 1862. It affected all the New York district. The lambs affected had the appearance of a general want of physical development at the time of birth. Some were brought forth so feeble that they never rose to suck. Those that survived required extra care and very few of them attained ordinary size and plumpness, however plentiful their supply of milk. Congenital goitre in some instances accompanied the preceding symptoms. In several flocks a few of the lambs were born with their heads and necks so drawn down, and occasionally also so twisted sideways by the action of the muscles that they could only suck with difficulty. In the same or other flocks another set of symptoms appeared. Strong healthy lambs, a week or two old, suddenly lost the use of their legs to a greater or less degree. Some hobbled about as if lame in every foot, others could scarcely walk. A portion grew no worse and after a few weeks recovered. A small number became unable to stand even when placed on their feet, but they continued to look healthy and feed heartily when assisted. The average loss from the disease in the larger infected flocks was about 50 per cent. Mr Randall's own flock lost 40 per cent., his son's 70 per cent., and a neighbour's 90 per cent. Referring to the causes, Mr Randall attributed it to the flocks of sheep in New York state being unusually confined in space during the winter of 1861-62. There were uncommonly deep snows and many flocks scarcely moved fifty yards from their stables during the last ten or twelve weeks of their pregnancy. It was noted by many flock-owners that they never before saw the sheep so quiet, so disposed to remain constantly in their stables and so fleshy towards spring. Gamgee himself (p. 328), writing on the subject of Joint-Ill states that the seasons during which it has been most rife have been remarkable for the good condition of the ewes, the heavy crop of lambs and abundance of food. He usually found that the flocks affected with this disease had been kept in a confined space during winter. The ewes had been well fed; but not allowed to move about sufficiently. He discounts the idea of contagion favouring the spread of the disease and as preventive he states that moderation in feeding is the great secret, so as to keep up the condition of the animals without having an excess of fat. Further, the animals should have plenty of exercise as it is bad for all breeding animals to be kept too quiet. *Shepherd Boy* (11, p. 309), also records an instance where faulty treatment of the ewes during pregnancy produced disastrous results in the lambs. He had charge on the same farm of two flocks, one a Shropshire, the other a Leicester-Shropshire cross. The Shropshires were a pedigreed stock, and as regards feeding, etc., were treated on a much more generous scale than the commercial Leicester-Shropshires. The Shropshires when they came to lamb gave birth to a large proportion of fat, swollen-necked, hoofless and almost boneless freaks, covered with a thin covering of hair rather than the natural curly growth of wool. Fifty per cent. of the Shropshire lambs died in this condition while not a case occurred among the commercial Leicester-Shropshire crosses. Next year the same Shropshire flock under similar treatment to that given to the Leicester-Shropshire gave pretty close to a 150 per cent. increase with only one case of diseased lamb to record. He remarks, further, that where sheep have unlimited exercise and have to work a little for their living, as it were, such lambs as those described above, are conspicuous by their absence.

It has been suggested above that the *modus operandi* of the disease is an infection of the tissues through gastro-intestinal disturbance. Brown (*loc. cit.*) in dealing with the disease in foals states that he is of opinion that there is a close relationship between the disease and gastro-intestinal disturbances, which in young highly bred foals are very common, generally serious and often fatal. Magnusson (*loc. cit.*) speaks in a similar sense. The most perfect analogy to the disease in lambs as I imagine it, however, occurs in "White Scour" or "Dysentery" of calves. This disease as is well known has as a common sequel Joint-Ill. It has been intensively worked at for a long period of years by Danish investigators, chief among whom is Jensen (quoted by Hutyra and Marek, p. 121). According to Jensen, Nocard, and their collaborators this disease is caused by the "Hæmorrhagic Septicæmia-Coli-intermediate-Coli" group of organisms. These are normal inhabitants of the intestine of normal healthy calves. If, however, the resistance of the tissues is weakened from some cause (cold, poor nutrition), the bacteria penetrate into the intestinal wall, and later into the distant organs (Jensen). The first cases may be sporadic, but the organisms involved gain increased virulence by passage, and through time the disease becomes a highly infectious one. Calves which have not yet taken any food are very susceptible to the disease and the disease may be set up *de novo*, by feeding such calves with boiled milk instead of colostral milk. Joest explains this by suggesting that the colon bacilli which enter the stomach before ingestion of colostral milk pass without interference into the small intestine as the stomach has not as yet produced any gastric juice and owing to the absence of the intestinal juices the meconium which is present in the intestine affords a favourable medium for the growth of bacteria. Penetration into the mucous membrane is probably also facilitated by the fact that the intestinal epithelium does not at that period possess a mucous covering.

The disease may be very acute or it may be more chronic. Joint disease is usually associated with the more chronic cases. New-born animals are much more susceptible or predisposed to the disease, while later the susceptibility diminishes. Conditions which predispose the body, such as poor nutrition, congenital weakness etc., favour the development of the disease, particularly if the animals have not a great resistance during the first days of life.

The condition of matters relative to White Scour and Joint-Ill in calves may be put briefly as follows. Owing to a lowered resistance or natural weakness of a new-born calf, the normal bacterial inhabitants of a healthy calf's intestine are capable of setting up a gastro-intestinal disturbance and an invasion of the tissues. By this means the disease may arise *de novo* in a previously healthy byre. The organisms, however, by the fact of having passed through and produced the disease in the original animal, get an access of virulence and are now capable of infecting strong healthy animals. Thus the infectious nature of the disease is accounted for. The important point, however, is the debilitated condition which allowed the disease to start in the original calf.

With regard to measures taken against the disease, these have largely consisted in the use of antisera. For a considerable number of years the administration of such antisera in cases of White Scour and Joint-Ill in calves has been on trial. It has not been a success, however. One of the reasons in all probability is not far to seek. White Scour and Joint-Ill are not caused by one single organism. Already, probably more than a dozen have been adduced as causal; and in any one case, one or several in combination may be acting. Now, an antiserum produced against one single organism, if active at all, is active against that organism alone, and sometimes even against a single strain of it only, namely the one used to produce it, so that in every one individual case of the disease the chances of using the right antiserum against the infecting organism or organisms are very meagre. The difficulties, economic and otherwise, in the way of producing a polyvalent serum active against all the organisms forbid much hope for success in the future in this direction. In conclusion, it may be stated that from this further study of the same and allied conditions, the provisional hypothesis as to the causation of Joint-Ill in lambs has been enlarged and supported. No success can be claimed for the use of antisera in the allied diseases of foals or calves, where there are considerably greater facilities for the economic application of such agents. The expense of preparation and the difficulties of administering such substances (even if they were of the greatest possible value, which has never been proved) to lambs of commercial stocks many of them running at large on the hills, would appear at the outset to bar such use. Apart from this, the apparently capricious occurrence of the disease from season to season as pointed out above, would appear to set limits to the correct adjudication of the value of any such treatment.

On the other hand, can anything remedial be suggested from the conception of the disease advanced in this paper? As already stated the view held here is that the disease arises owing to the lowered resistance of the young animal thus enabling organisms, present in the normal fœces of healthy animals, to set up a gastro-enteritis. Such lowered resistance may be due to pre-natal or post-natal conditions, some of which have been specified above. The endeavour should be made, therefore, to counteract such influences. In addition, as these normally present organisms may have their virulence increased by *passage*, and so become in fact the agents of a veritable infectious disease in certain cases, appropriate measures should be taken to limit the spread of infection.

I have to thank numerous farmers and shepherds for their kindness in supplying me with material and information. I am also indebted to Mr Jas. K. Bell, Agricultural Officer for Roxburgh and Berwick, for generously helping me in connection with this investigation.

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Co-operative Dairying in Wigtownshire.

THE Port-William Dairy Farmers' Association Limited was started with a view to preventing the price of milk in Wigtownshire from falling after decontrol to the low level that had previously prevailed. There were several factors which tended to make the price lower than that obtained by farmers in other districts; the chief one was, of course, the distance from the large towns which meant that, in addition to bearing a heavier freight charge, the milk could not be delivered in the morning when it would command the best price. In the second place there existed in some quarters a prejudice against South country milk as it was believed that the cows were fed only on turnips and straw except when the milk was to be used for cheese making. This is an erroneous idea, as all Wigtownshire farmers are not cheese-makers while the quantity of feeding stuffs consumed in the South is as large per cow as in Ayrshire.

It was accordingly thought that by a system of co-operation and the elimination of the middleman a better price might be obtained, while surplus milk could be converted into cheese. It was also felt that agricultural requisites might be purchased to better advantage than under the existing conditions and the Association was entered upon with these two objects in view.

The success attained by Co-operative Dairies in Ayrshire was a stimulus to similar effort and after the services of an organiser from the Scottish Agricultural Organisation Society had been obtained, a deputation from the newly formed Association visited some of the Ayrshire Creameries with a view to learning from them what methods had been found most successful and how to avoid such mistakes as they might have made.

The site fixed upon for the Factory—a disused sawmill—had several advantages; the original building was in a fair state of preservation; there was a good supply of pure spring water and the sewage had only a run of about 100 yards to the sea; while there was also good accommodation for rearing and fattening pigs; but it has the disadvantage of being about six miles from a railway station. It was decided that, with an abundant supply of sand and gravel at hand a concrete building would be most economical and the plans were put in hand at once.

The question of transport was the next to be decided and after consultation with various authorities three steam motor wagons were purchased, one being obtained straight away for use in hauling materials for the construction of the creamery.

Practically every farmer and small holder in the district had joined the Society but while the numbers were sufficient to ensure the success of the undertaking more capital was needed. Under the Industrial and Provident Societies Acts the share capital is limited to 200 fully paid up £1 shares per member and even had every member taken up this amount the capital would still have been insufficient to meet the high cost of buildings etc. It was decided therefore to create debentures in the form of a levy on cows, each member being expected to hold a number of shares for each cow whose milk was being handled. This, however, did not meet the case altogether and it was felt to be a burden on some of the small holders. The Board of Agriculture was therefore approached for a loan and £3500 was lent at a nominal rate of interest.

The managers of the two departments (the Creamery and the Trading Department) took up duty in December 1920. Arrangements were made for the collection and disposal of the milk and orders were taken for feeding stuffs, manures, seeds, implements, etc. It was soon evident that one of the wagons would have to be allocated to the Trading Department, while a store, weigh-bridge and office were also procured.

The Creamery was equipped with up-to-date apparatus for cleaning and chilling milk and with an outfit for washing cans consisting of hot water tanks and cold and hot sprays.

When the supply of milk exceeds the demand the surplus is made into cheese. The cheese-making plant is also of the best type obtainable and ensures the cleanliness of the product. The milk passes from the weigh-bridge to the tanks and hence over a heater and through the cleaning machine to a chute which carries it to the vats, after which it goes through the usual processes.

No charge is made for hauling the milk so that the farmers furthest from the Creamery suffer no disadvantage thereby. When the milk is received from the farmer it is weighed and a check is given. The milk is paid by the month on the 21st of the month following, so that it is known exactly what the products have realised. Working expenses only are deducted and any profits are allocated among the members as a deferred payment.

Labour is reduced to a minimum and from the point of view of the producer the undertaking is highly successful. In the month of January 1921, 2/6½d. per gallon was paid by the Creamery for milk, a price hitherto unobtainable in Galloway. During the flow 3500 gallons of milk were handled per day and about 45 cheeses of 80 lb. each were made. In the ten months since it began the Creamery has dealt with 603,343 gallons of milk and has turned out over 7279 cheeses. The cheese has brought good prices, in many cases higher than that obtainable for farm cheese.

Thus it is evident that Co-operative Dairying can be highly successful since this factory was built at a time when building costs were at their highest.

Calf Feeding in New Zealand.

THE following particulars are extracted from the New Zealand *Journal of Agriculture*.

With the object of obtaining reliable data as to what extent supplementary foods (mainly home-grown) can be profitably substituted for milk and whey, a scheme of feeding tests, combined with the best practice in calf-rearing generally, was undertaken at the Ruakura and Weraroa Experimental Farms in 1919. In each case sixteen calves were divided into four groups of four each and fed strictly on the respective dietary assigned to each group for seventeen weeks. The results were satisfactory; there have been no deaths, and the calves are in excellent health.

At Ruakura, the calves comprised twelve Shorthorns, four Shorthorn x Jersey crossbreds; at Weraroa the calves used were crossbreds comprising Friesian x Jersey, Shorthorn x Jersey, Ayrshire x Jersey, Friesian x Shorthorn, Guernsey x Jersey and also grade Jerseys.

The substitute feeds at Ruakura were prepared as follows:

Group I:—Whole linseed flour soaked overnight in water and and boiled for twenty minutes next day; flour mixed with a little water and added five minutes before boiling is completed.

Group II:—Boiling water added to linseed meal and bean meal, the whole covered up for twenty-four hours.

Group III:—Oat meal, and crushed linseed made into porridge and mixed hot with skim-milk.

Group IV:—Dry crushed linseed stirred into the skim-milk immediately before feeding.

TABLE I.—*Results of Feeding Tests at Ruakura.*

Group	Feeding formula per head per day	Weights and gains	Cost of food per head
		lb.	£ s. D.
I	For 2 weeks: Whole milk . . . . 8 lb. For 15 weeks: Whole linseed . . . 8 oz. Flour . . . . 2 oz. *Skimmed milk . . . 15 lb.	Total first weight . . . 301 Total final weight . . . 1071 Total gain . . . . . 770 Average daily gain per calf 1·61	1 14 11
II	For 2 weeks: Whole milk . . . . 8 lb. For 2 weeks: Linseed meal . . . 7½ oz. Bean meal . . . . 12 oz. Skimmed milk . . . 8 lb. For 13 weeks: Ditto minus skimmed milk . .	Total first weight . . . 302 Total final weight . . . 952 Total gain . . . . . 650 Average daily gain per calf 1·36	1 S 1
III	For 2 weeks: Whole milk . . . . 8 lb. For 15 weeks: Oatmeal . . . . . 8 oz. Crushed linseed . . 9 oz. Skimmed milk . . . 15 lb.	Total first weight . . . 303 Total final weight . . . 1036 Total gain . . . . . 733 Average daily gain per calf 1·54	1 19 6½
IV	For 2 weeks: Whole milk . . . . 8 lb. For 15 weeks: Crushed linseed . . 9 oz. Skimmed milk . . . 15 lb.	Total first weight . . . 301 Total final weight . . . 1148 Total gain . . . . . 847 Average daily gain per calf 1·77	1 14 7

From the foregoing Table it is evident that the dry crushed linseed added to skimmed milk gave the highest daily increase in weight. A considerable amount of difficulty was experienced in getting the calves to take bean and linseed meals (Gr. II), but it was found that after twenty-four hours the food had a sour smell.

The substitute feed at Weraroa was prepared as follows:—

Group I:—Linseed soaked overnight in 2½ pints of water, boiled next day for twenty minutes, adding flour (previously mixed to a smooth paste with cold water), five minutes before boiling is completed.

Group II:—Crushed oats fed dry.

Group III:—Linseed boiled to a jelly in water.

Group IV:—Boiling water added to linseed meal, plus bean meal, the whole mixed and covered for twenty-four hours.

TABLE II.—*Results of Feeding Stuffs at Weraroa.*

Group	Feeding formula per head per day		Weights and gains	lb.	£	s.	d.
I	For 2 weeks:						
	Whole milk	8 lb.	Total final weight (17 weeks)	979		17	3½
	For 7 weeks:						
	Skimmed milk	16 lb.	Total gain	718			
	For 18 weeks:						
	Flour	4 oz.	Average daily gain per calf	1·5			
	Linseed meal	3 oz.					
II	For 2 weeks:						
	Whole milk	8 lb.	Total final weight	1102		19	10½
	For 2 weeks:						
	Skimmed milk	16 lb.	Total gain	822			
	For 13 weeks:						
	Crushed oats	1 lb.	Average daily gain per calf	1 7			
III	For 2 weeks:						
	Whole milk	8 lb.	Total final weight	1032	1	7	3
	For 15 weeks:						
	Skimmed milk	16 lb.	Total gain	770			
	Linseed gruel	1 qt.	Average daily gain per calf	1·6			
IV	For 1 week:						
	Whole milk	8½ lb.	Total final weight	1355		18	10
	For 1 week:						
	Skimmed milk	16 lb.	Total gain	1077			
	For 15 weeks:						
	Bean meal	8 lb.					
	Linseed meal	6 oz.	Average daily gain per calf	2·3			
	Warm water	3 qt.					

Cost of food per head given in the last three columns.

The author remarks in conclusion that the most important and essential factors in calf rearing (apart from the diet) are: a clean new grass paddock; a good supply of fresh drinking water; clean feeding utensils. There is no doubt that the absence of scour among the calves was due largely to the latter precaution.

* * *

THE following is a summary of a Communication to the International Institute of Agriculture by Dr Kallbrunner, their Austrian Correspondent:—

Milk and Infectious Disease.

Before the war, British and German scientists found that an increase in the consumption of milk was accompanied by more cases of scarlet-fever but they were not able to find out the cause of this correlation. Austrian medical men and statisticians had attempted in vain to discover the correlation before the war, but during the war they were successful. In Vienna, the singular discovery was made that in the same degree as the town's milk supply decreased, so did the cases of scarlet-fever, this confirming British observations. Statistics collected by the

Office of Hygiene at Vienna show that the number of cases of scarlet-fever were as follows:

Year	Number of Cases	Year	Number of Cases
1910	4038	1915	5093
1911	4006	1916	4534
1912	4216	1917	3134
1913	5752	1918	2832
1914	4614	1919	1234

The cause of this phenomenon is unfortunately not yet known, but it is thought that the constitution of children nourished on milk is more open to attack by the fever microbes, as they do not possess enough natural organic means of reaction to combat the disease. A considerable amount of research work on this subject is still necessary.

Typhus has almost disappeared in Vienna since the construction of the two large conduits which ensure the increased supply of pure fresh mountain water. Unfortunately isolated cases still occur and these apparently indicate the important part played by milk as the transmitting agent, the victims' having often been found to have obtained their milk from the same dairy. This observation was naturally of great importance to the medical experts, and at the appearance of each new case they immediately concentrated their attention on the dairies which had supplied the victims' milk. The success of these precautions is shown by the continuous decrease of sporadic cases of typhus as well as small epidemics (certainly the cases of typhus in Vienna could not be prevented from increasing and it speaks very well for the efficiency of the measure taken, that the isolated cases did not develop into epidemics owing to soldiers who were on leave or had deserted, passing through the town).

The interesting cases cited further on, which were registered prior to the war and which led to the re-organisation of the dairies during serious times, prove how well justified were the rigorous measures taken by the sanitary police, in regard to the milk industry. Naturally these measures were taken in complete accord and collaboration with the dairies, which are always eager to produce and deliver the milk under irreproachable hygienic conditions.

Previously no special importance had been attached to the state of health of the personnel of the dairies, periodical washing and visits to the doctor being considered enough. Some years ago, a "koster" (a man who had to taste the milk from each can sent to the dairy) contracted typhus. Without falling seriously ill himself, he infected part of the milk he had tasted. About three weeks after the man fell ill ninety persons who had bought milk at this dairy became ill one after the other. The first to catch the disease were some employees who were in the habit of drinking milk from this dairy at lunch time. A careful search was at once made, and the case of the "koster" was discovered; about the end of three weeks, the epidemic of typhus disappeared automatically, but not before it had caused the death of a dozen persons.

In another dairy where a pasteuriser was broken, doubtful milk was sold during three or four days without being pasteurised. Although the time was so short, this negligence unfortunately caused a small epidemic, which broke out three weeks after, but although it was of short duration, it nevertheless proved fatal to many persons.

In Austria it is generally believed that tuberculosis is transmitted from the cow to man through the milk, but this fact is not scientifically established for certain and, although public opinion is to the contrary, primary intestinal tuberculosis is rare. In Dalmatia, where milk is not drunk, tuberculosis is very common, whilst in places where milk-drinking is on the increase, the disease is decreasing. In Vienna, where the milk consumption is decreasing, tuberculosis is increasing, obviously on account of other factors, as can be seen from the following Table:

Year	Milk consumed per day litres	Deaths due to tuberculosis
1914	900,000	6 223
1919	40,000	10,606

But in spite of the bad feeding and poor attention that the cattle received during the war, bovine tuberculosis is on the decrease. One reason of this was the requisitions from the farmers, who, being paid extremely low prices with no reference to weight or quality, delivered the worst they had got, the animals being usually those most susceptible to tuberculosis. Some livestock owners even applied BEHRINGS inoculation test for tuberculosis so that they could dispose of animals shown to be infected.

This elimination of poor and doubtful animals has certainly had a beneficial effect on the general state of health of the cattle and this is shown by the fact that the number of insurances paid by the "Nieder-Oesterreichische Landes-Vieh-Versicherungs-Anstalt," (Cattle Assurance Company of Lower-Austria) for cattle slaughtered owing to tuberculosis has been steadily decreasing since 1913. Thus, out of 100 insured animals killed by order the number of cases from 1913 to 1918 where slaughter was due to tuberculosis was as follows:

1913-1914	1305 cases
1914-1915	1129 „
1915-1916	952 „
1916-1917	790 „
1917-1918	553 „

In 1918, the number of cases slaughtered increased slightly but cannot be taken as an average, owing to the small number of cattle on which insurance was paid that year; observations made elsewhere confirm this statement.

This fact, which necessitates still further statistical confirmation, suggests that there is no correlation between bovine and human tuberculosis as statistics collected by the Ministry of Health at Vienna and the reports of the Nieder-Oesterreichische Lands-Vich-Versicherungs-Anstalt of Vienna show that while bovine tuberculosis is diminishing, human tuberculosis is increasing.

Agricultural Progress.

AT a meeting of the Royal Statistical Society on 15th November, Sir R. Henry Rew delivered his second presidential address, taking as his subject "The Progress of Agriculture." He pointed out, as reported in "Nature," that the total land area of Great Britain is now 56¼ million acres, and of the 52¾ million acres capable of productive use about 90 per cent. is so utilised in a greater or less degree. This area is not capable of any material extension. The proportion of arable land was 58 per cent. in 1869–78, and is now 48 per cent., but the prevalent belief that the output of British agriculture has declined, overlooks the fact that the smaller arable area may, if devoted to other crops, produce a greater amount of food than the larger. By substituting potatoes for wheat, for instance, one-fifth the area would give about as much food Fruit and vegetables have also largely replaced farm crops while the extension of cultivation under glass has resulted in a great increase of output per acre. As regards livestock, comparing the ten years 1869–78 with 1912–21, there has been a net gain of about 750,000 beasts. There has also been a progressive and substantial increase in milk production during the past fifty years, the milking herds having increased by 32 per cent., while the yield per cow has also been greatly increased. At the outbreak of war a larger quantity of food was being produced than at any previous period. During the war there was a set back in food production, the amount of cereal food being increased, but other kinds of food being markedly reduced. Whether the pre-war standard of total output has been regained is regarded as doubtful but such facts as are accessible point to the conclusion that the output of food has been increased. Indeed, the agricultural land of the country is capable of producing more food, for on a large proportion of it the output is undoubtedly lamentably deficient.

Agricultural Returns for Scotland, 1921.

THE Abstract of the Agricultural Returns printed on pp. 109–116, shows that the total area under all crops and grass amounts to 4,729,604 acres, a decrease of 9,442 acres as compared with 1920, the arable land having decreased by 31,170 acres, while the area under permanent grass is greater by 21,728 acres. The land

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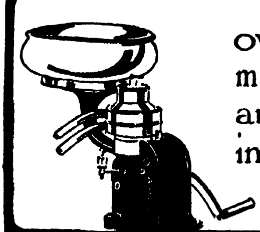

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under rye-grass and other rotation grasses and clover has increased by 38,792 acres; the decrease in area under other crops is thus 69,962 acres. The area under wheat is greater by 10,832 acres, or 19·93 per cent., that under barley has decreased by 33,648 acres, or 16·46 per cent., while that under oats is less by 20,583 acres, or 1·99 per cent. The total area under the cereal crops is 1,247,527 acres, or 43,399 acres less than last year. Beans show a decrease of 1,022 acres, or 17·85 per cent. Potatoes have decreased by 8,657 acres, or 5·33 per cent., while the area under turnips and swedes is less by 14,465 acres, or 3·40 per cent. The area under flax has decreased by 1,186 acres, the acreage being 452 as compared with 1,638 last year. Rape shows an increase of 1,838 acres, or 12·35 per cent., while the acreage under vetches, tares, etc., for fodder is lower by 1,080 acres or 9·69 per cent. Of the other crops, peas, mangolds, cabbage, and small fruit show small increases, while decreases are recorded for vetches or tares for seed, carrots and onions. The increase in the area under rotation grasses and clover is 38,792 acres, or 2·70 per cent., the area for hay being less by 14,700 acres, while that for pasture shows an increase of 53,492 acres. The area under permanent grass is greater by 21,728 acres, or 1·60 per cent., the area for hay being less by 9,200 acres, while that for pasture was greater by 30,928 acres. The total area cut for hay was 553,520 acres, or 23,900 acres less than last year.

The area under wheat, barley, oats, and potatoes this year is, in round figures, 1,401,000 acres; this is 52,000 acres less than last year but 48,000 acres more than in 1916, which was the basal year for the food production campaign.

The live stock returns show that the numbers of horses, sheep, and pigs have increased, while cattle have decreased. Horses used for agricultural purposes are more numerous by 966, "other horses" by 847, and unbroken horses by 471, the gross increase thus amounting to 2,284, or 1·07 per cent. Cows in milk have decreased by 3,620, or 1·03 per cent.; cows in calf have increased by 3,587, or 9·41 per cent., and heifers in calf by 8,602, or 18·61 per cent. The total number of breeding and milking cattle has thus increased by 8,569. Bulls used for service have increased by 739, or 4·17 per cent. Other cattle of two years and above have increased by 24, or 0·01 per cent., and those under one by 5,016, or 2·32 per cent., while those of one year and under two, show the large decrease of 36,925, or 13·72 per cent. The number of cattle has thus decreased by 22,577, or 1·94 per cent. All classes of sheep are more numerous than in 1920, the total number showing an increase of 297,583, or 4·68 per cent. Breeding ewes have increased by 58,388, or 2·12 per cent., rams by 2,708, or 3·50 per cent., other sheep of one year and above by 16,202, or 1·60 per cent., and lambs by 220,285, or 8·76 per cent. All classes of pigs have also increased, sows kept for breeding by 3,382, or 23·20 per cent., boars used for service by 322, or 20·06 per cent., and other pigs by 13,235, or 11·78 per cent. The total increase in the number of pigs amounts to 16,939, or 13·18 per cent.

The returns collected this year include statistics of the acreage owned by the occupiers of the holdings; this information was obtained also in 1920, but, in addition, statistics relating to labour and poultry have now been collected for the first time. None of these figures is included in the printed Abstract.

The total area of land under crops and grass owned by occupiers of holdings this year amounts to 746,663 acres, as compared with 606,007 acres in 1920, showing an increase of 140,656 acres.

Labour employed on holdings (exclusive of the occupiers, their wives and domestic servants) totalled 126,898. Of these 103,871 were returned as regular workers, and 23,027 as casual workers. Regular workers comprised 82,099 males, and 21, 772 women and girls, while casual workers were made up of 11,544 males, and 11,483 women and girls.

The poultry figures are as follows:—

Fowls hatched before 1921 . . .	2,094,849
Fowls hatched this year . . .	2,120,966
Ducks hatched before 1921 . . .	126,607
Ducks hatched this year . . .	112,970
Geese hatched before 1921 . . .	5,794
Geese hatched this year . . .	17,645
Turkeys hatched before 1921 . .	11,737
Turkeys hatched this year . . .	57,930

Leaflets.

THE leaflets issued by the Board, and also those issued by the Ministry of Agricultural and Fisheries, have until recently been distributed by the Board free of charge to residents in Scotland. In view, however, of the increased cost of printing and paper, and the need for economy in Government expenditure, it has been decided that a charge must be made in all cases where more than two leaflets are required.

Persons who require information on a definite point dealt with in one of the leaflets can, therefore, obtain the leaflet in question free of charge, but if several leaflets are required, a charge will be made at the rate of 1d. each, or 9d. per dozen, post free. Sectional volumes, containing groups of leaflets dealing with specific subjects, have been published by the Ministry of Agriculture and Fisheries, and these may be purchased from the Board by residents in Scotland.

Leaflets required by Education Authorities, Agricultural Colleges, Farmers' Clubs, Allotment Societies, etc., for distribution, will be supplied at the rate of 4s. per 100, carriage free.

Sectional volumes, bound sets of leaflets and miscellaneous publications will be supplied in quantities of twenty and upwards to the above-mentioned bodies (but not to private individuals) at 10 per cent. discount on the published price.

Annual Estimates of the Produce of Crops. THE following statement regarding the produce of crops for 1921 was issued on 9th December.

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots in Scotland in the Year 1921, with COMPARISONS for 1920, and the AVERAGE YIELD PER ACRE of the Ten Years 1911–1920.

Crops.	Estimated Total Produce.		Acreage.		Average Estimated Yield per Acre.		Average of the Ten Years 1911-1920
	1921.	1920.	1921.	1920.	1921.	1920.	
	Quarters.	*Quarters.*	*Acres.*	*Acres.*	*Bushels.*	*Bushels.*	*Bushels.*
Wheat	312,000	260,000	65,191	54,359	39·4	38·2	39·6
Barley (including Bere)	739,000	973,000	170,721	204,369	34·6	38·1	35·6
Oats	4,793,000	5,157,000	1,011,615	1,032,198	37·9	40·0	39·2
Beans	18,700	26,900	4,704	5,726	31·7	37·6	36·9
	Tons.	*Tons.*			*Cwt.*	*Cwt.*	*Cwt.*
Hay from Rotation Grass	581,000	694,000	410,556	425,256	28·3	32·6	30·9
Hay from Permanent Grass	118,000	143,000	100,253	104,966	23·6	27·3	30·2
Hay from Timothy Meadows	87,000	105,000	42,711	47,198	40·8	44·6	
					Tons.	*Tons.*	*Tons.*
Potatoes	1,040,000	1,237,000	153,820	162,477	6·8	7·6	6·5
Turnips and Swedes	7,132,000	7,692,000	410,789	425,255	17·4	18·1	16·3
Mangolds	35,000	29,000	1,771	1,768	20·0	16·4	19·4

The sowing of wheat was carried out under favourable conditions generally. The crop brairded well and, although growth was checked to some extent by frost in March and April, progress on the whole was normal, and there was no recurrence of the bulb-fly pest which was so prevalent in 1920 and which caused such widespread damage. Wheat withstood the drought of May, June, and July the best of the cereal crops, except on light lands, and ultimately yielded very satisfactorily. Barley and oats were sown in good order but progress was slow in most cases owing to the abnormally dry weather. Straw was short generally, and the yield of grain was less satisfactory than in the case of wheat.

The planting of potatoes and the sowing of roots were accomplished in good time and under excellent conditions. Potatoes and turnips suffered severely owing to the long spell of dry weather, and although the rainfall during August was of great benefit the crops did not fully recover, and the yields were below those in 1920. Potatoes generally were free from disease, but heavy damage was caused to turnips owing to mildew. Mangolds were a good crop, and, as will be seen, the yield was well above the normal.

The total produce of Wheat, amounting to 321,000 quarters, is greater than that of last year by 61,000 quarters, or 23·5 per cent.; the area under the crop is higher by 10,832 acres, while the yield per acre, 39·4 bushels, is 1·2 bushel above that of last year and almost equal to the decennial average. Barley, with a total produce of 739,000 quarters, shows a decrease of 234,000 quarters, or 24 per cent.; the area under the crop is less by 36,648 acres and is the lowest since 1918. The yield per acre, 34·6 bushels, is 3·5 bushels below that of last year and is 1 bushel below the decennial average. The total produce of Oats, 4,793,000 quarters, falls short of last year's crop by 364,000 quarters, or 7·1 per cent. The area under the crop shows a diminution of 20,583 acres; the yield per acre, 37·9 bushels, is 2·1 bushels lower than last year and 1·3 bushel below the decennial average. The area under Oats this year is the lowest since 1916. Beans show a decrease in total produce of 8200 quarters; the area under the crop is less by 1022 acres and is the lowest on record. The yield per acre, 31·7 bushels, is 5·9 bushels lower than in 1920 and is below the decennial average by 5·2 bushels.

The total produce of Hay, taking all kinds together, is 786,000 tons, which is less than that of last year by 156,000 tons, or 16·6 per cent. Hay from Rotation Grass shows a total produce of 581,000 tons, a decrease of 113,000 tons, or 16·3 per cent. The area is less by 14,700 acres, while the yield per acre, 28·3 cwt., is 4·3 cwt. below last year's yield and 2·6 cwt. lower than the decennial average. Of the other Hay, the total produce of which amounts to 205,000 tons, the ordinary Meadows yielded 118,000 tons, and the Timothy Meadows 87,000 tons; the former, with a decrease in area of 4713 acres, shows a yield 3·7 cwt. below that of last year, while the latter, with a decrease of 4487 acres in area, shows a yield lower by 3·8 cwt. The average yield of the two together, which is not shown in the Table, is 28·7 cwt., or 1·5 cwt. below the decennial average.

The total produce of Potatoes is estimated at 1,040,000 tons, which is 197,000 tons less than the record crop of last year. The area under the crop shows a decrease of 8657 acres, while the yield, 6·8 tons per acre, is 0·8 ton less than in 1920, but is 0·3 ton above the decenial average. Turnips and Swedes show a decrease of 560,000 tons, the total being 7,132,000 tons. The area under the crop is less than last year by 14,466 acres; the yield per acre is 0·7 ton lower than in 1920, but is 1·1 ton higher than the decennial average. Mangolds, with a total produce of 35,500 tons, show an increase of 6500 tons; the area is practically unaltered, but the yield per acre, 20 tons, is 3·6 tons higher than last year and is 0·6 ton above the decennial average.

Agriculture Conditions.

THE weather during September was generally favourable for harvest operations, and in most cases the grain crops were secured in good order. In the northern and north-eastern counties the weather was exceptionally dry; root crops were checked owing to the lack of moisture, and water supplies were abnormally low in several districts in these counties. During the greater part of October the weather was mild and comparatively dry. Speaking generally, the month was favourable for the completion of the oat harvest and for outdoor work of every description, the only exceptions being in Orkney, Shetland, and the western islands, where the weather was broken and the rainfall heavy. Mild weather, with a moderate rainfall, prevailed during the greater part of November and, on the whole, the month was very favourable for the normal work of the season. There were some frosty nights towards the end of the month, and some snow in the north-eastern districts, but, on the whole, operations proceeded practically without interruption throughout the mainlaind of Scotland. Orkney, Shetland, and the western islands were again, however, the exceptions to the general rule; in these parts the month was mostly wet and boisterous and outdoor work was more or less interrupted.

The cutting of wheat started in most districts about the middle of August, and harvest was completed generally before the end of the third week in September. The crop was secured in most cases in good order, and in some districts was the best for several years. A few reports indicated that damage had been caused by sprouting and in some districts there was an unusually heavy loss of grain in handling. The total yield is estimated to be 61,000 quarters greater than last year, and the yield per acre was also higher. The harvesting of barley was completed in the great majority of the districts by the third week in September. The total yield shows a decrease of 234,000 quarters, and the yield per acre is also lower than last year. The oat harvest began in some districts early in August, but cutting was not general until about the end of that month. Harvest was completed in most of the mainland districts before the end of September, but the work was very prolonged in Orkney, Shetland, and the western islands, owing to unfavourable weather. In these districts cutting was not quite completed until about the end of October, and in some cases, the beginning of November. The crop was an excellent one in a few districts but, taking the country as a whole, the quality of the crop was much less satisfactory than that of wheat or barley. The total produce falls short of last year's crop by 364,000 quarters, the acreage under the crop and the yield per acre both being below those in 1920.

The lifting of potatoes was completed, or practically completed, in most districts by the end of October. The reports on the crop are somewhat varied but, on the whole, the yield was fairly satisfactory and the crop comparatively free from disease. There has been a considerable amount of second growth in many districts. In Harris, Lewis, and Uist, disease has been very prevalent, and in these districts the crop is seriously below the average; in Orkney and Shetland the crop has also been an indifferent one, although not so bad as in the western islands. The total produce is 197,000 tons less than the record crop of last year.

The lifting of turnips and swedes was completed or well advanced in several districts at the end of November, but in many cases they are only being lifted as required. The crop generally is a fair one in the western countries, but elsewhere swedes are at best an average crop while turnips are more or less below the normal. Mildew has been widespread and finger-and-toe has been prevalent in several districts; turnips have been more seriously affected than swedes, and the keeping properties of the crop are considered to be rather doubtful. The total yield is 560,000 tons less than last year, the area and yield per acre both being lower than in 1920. Mangolds are everywhere a full average crop of good quality. The total yield shows an increase of 6,500 tons as compared with last year.

"Seeds" grass is almost everywhere reported to be vigorous and healthy, and in many cases the growth is described as being abnormally strong.

The conditions during October and November were very favourable generally for outdoor work and good progress has been made with autumn cultivation throughout the mainland districts. Wheat-sowing was completed at the end of November in several districts, and elsewhere was well advanced, and in all cases the seed was got in in good order. In some instances, early sown fields were at that time already showing a strong braird.

Feeding cattle are generally in good condition and have made average progress. Grass has been plentiful, thus effecting an economy in winter keep which in some districts is rather short. Dairy cows are also favourably reported on. The milk yield has been well maintained on the whole, and in some instances has been unusually plentiful for the winter season. Sheep have progressed generally, and the ewe flocks are in good condition. Several cases of braxy have occurred amongst wintering hoggs in Sutherland.

The supply of regular workers and of casual labour is ample for requirements in most districts, and in some parts is in excess of the demand. In Renfrew and North Ayr, however, women dairy workers are scarce, and in several districts the supply of domestic servants is short of requirements.

National Physical Laboratory.

A PAMPHLET entitled "Tests on Volumetric Glassware used in Dairy Chemistry" has recently been issued by the Metrology (Glass Testing) Dept. of the National Physical Laboratory. The pamphlet deals with the different types of butyrometers, pipettes and other appliances for testing milk and milk products. Single copies may be obtained free of charge on application to the Director at Teddington, Middlesex. Additional copies are charged 6d. each plus postage.

RECENT PERIODICAL LITERATURE.

The majority of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins, and to the original publications quoted therein, may be obtained on application to the Secretary, Board of Agriculture for Scotland, 29 *St Andrew Square, Edinburgh.*

Experiments on the Soaking of Seeds. *P. Bachelier, etc., Comptes rendus de l'Acad. d'Agric. de France.*—According to certain authors the yield of cereals can be increased by soaking the seeds in a solution of potassium nitrate or ammonium nitrate, the theory being that the grain is strengthened and nourished during its period of growth.

M. BACHELIER has experimented with seed soaked for six hours in pure water, and in 10 per cent. and 20 per cent. solutions of potassium nitrate or ammonium nitrate.

In 1919, soaking barley grains in pure water assisted the plants to spring up during dry weather. Saline solutions had, however, a harmful effect, which was greater with ammonium nitrate solution than potassium nitrate, and increased as the solution was more concentrated.

The idea of manuring seeds is not new, and M. DUHAMEL-DUMONCEAU in his *Elements d'Agriculture*, 1760, devoted a long chapter to his experiments on this subject, the results of which were always negative.

M. VIGER remarked on the experiments made by the farmers of the Loiret district who have obtained the same results as M. BACHELIER.

There is no doubt, according to M. SCHRIBAUX, that soaking in a very dilute solution is a help to germination, but the effect seems to be due solely to the action of the water. The effects of solutions and pure water have been compared and the latter generally gives the best results.

M. PETIT mentioned his own experiment which dates back twenty years and said that soaking beet seed in pure water gave good results during dry years, but solutions of fertilisers always gave bad results.

Having made grains of barley absorb sugar, in order to see whether germination was accelerated or not, M. LINDET found that the sugar had no effect on germination. The grain contained enough carbohydrates for shoot formation and it was useless to add any fertilisers to aid germination.

In fact, concludes M. VIGER, all the results show that it is simply the co-efficient of humidity of the grain which may be advantageous under certain circumstances.

Formation of Nitrate in a Soil following the Growth of Red Clover and of Timothy. *T. L. Lyon, etc., Soil Science, Balt.*—The authors first give a brief review of former experiments, but state that the results reported leave some doubt whether the legumes used increased the nitrifying power of the soil for dried blood, as compared with the influence of non legumes, except when crop residues alone were concerned, when favour of the legumes was unanimously expressed. The authors deal with the question in a new way and the experiment described involved the leaching of soil on which different crops were growing.

Twelve cylinders were fitted with soil of medium fertility and good drainage qualities, limed and fertilised with acid phosphates, muriate of potash and dried blood. Six were planted with timothy and six with red clover. The soil of all the cans was inoculated with a pure culture of *Bacillus radicicola* from clover nodules. Each also received 1000 cc. of an infusion made by stirring 1 lb. garden soil with 3 litres of tap water to insure an active nitrifying flora.

During the growing period, the soil was leached with distilled water periodically. After these crops were removed, the soil was allowed to remain in fallow for a month. Oats and maize were then planted, but cylinders kept free from vegetation. Leaching was continued from time to time and nitrogen determinations made in every case.

The experiment brings out certain data which may be significant. Under the same conditions of soil and treatment, clover caused a greater production of available nitrogen than timothy. The effect is shown in the nitrate content of the drainage water and the total nitrogen content of the oats and maize. Furthermore, only a minor part of the total nitrogen probably remaining in the roots of the clover crop was nitrified before the rate of nitrate production in the clover soil fell to that of the timothy soil.

Soil Reaction as Influenced by Green Manures. *L. P. Howard, Soil Science, Balt.*—A brief review by the author of the literature dealing with the practice of green manuring serves to indicate that the quantitative evidence for and against this question is very limited. This is followed by results of work on soil samples collected at various periods during the season at Rhode Island Station 1915 and 1916, showing the changes in acidity, and also in organic matter on a legume and a non-legume plot. Samples were taken at frequent intervals from the date of ploughing, and lime measurements then made.

This work showed that variations are maintained in dried soils as manifested in their ability to retain different amounts of ammonia.

The net result over the period of two years indicates a decreased acidity except in the legume plot and suggests that the rye caused an increased requirement of 33 lb., while the legume caused an increase of 370. It should be noted that the last application of lime was made in 1914 in one ton of finely ground limestone per acre when considering net changes in lime requirement during 1915 and 1916.

With regard to hydrogen-ion concentration in soils it is significant that with the rye plot the variations follow in a general way the fluctations in lime requirement.

In the uncropped soils treated in the laboratory with an equal weight of green rye as compared with clover, the rye increased the lime requirement 300 to 400 lb., or about twice as much as the clover, and the increase was maintained from July to December.

The author considers it advisable to state that these results were scarcely an index of the net cumulative effect exerted by the clover crops through a longer period of time.

The Influence of Lime on the Nitrification of Farmyard Manure in Arable Soil. *C. Barthel and N. Bengtsson, Soil Science, Balt.*—It is well known that the part of nitrogen in solid manure that is first nitrified in the soil is the ammonia nitrogen, but only a part is nitrified during the first year of growth, even under the most favourable conditions. Hence the desire to ascertain whether the fertilising action of the manure could be enhanced by the application of any of the chemical fertilisers easily obtainable.

The first factor considered was lime, and a record was kept of the exact methods adopted. The following ingredients were mixed with the soil: (1) ammonium sulphate: (2) sulphate of ammonia and calcium carbonate; (3) farmyard manure; (4) manure—lime: (5) no admixture (control). The various mixtures were then placed in glass jars holding five kg. each, and these were then sealed down to prevent evaporation. At regular intervals samples were analysed for their content of nitrate-nitrogen, ammonia-nitrogen and moisture.

All the experiments tend to show that on the addition of lime, in the form of calcium carbonate, and farmyard manure to cultivated soil of both neutral and acid reaction, no favourable action of the lime on the nitrification of the farmyard manure resulted, but on the contrary an impeding effect occurred in the cases where the lime was applied in large quantities, larger probably than that applied in ordinary practice.

It is not easy to explain the cause of the impeding action of lime, but at any rate, it may be concluded that the lime does not have either an impeding or stimulating action on nitrification of the manure in the soil when supplied in recognised quantities.

The Influence of Sulphates on the Vegetative Growth and Composition of Plants. *H. G. Miller, Jour. of Agric. Research, Washington.*—The author summarises previous work on the oxidation of sulphur in the soil and the influence of the resulting products on (*a*) vegetative growth; (*b*) the development of the bacteria and their activity; (*c*) the liberation of other food material for the plants. On account of the good effect of fertilisers containing sulphur found in Oregon, the author undertook some greenhouse experiments in order to study the effect of sulphur on the early growth and the composition of plants, and to ascertain whether sulphur acts directly on plants by furnishing them with food or in some other way.

The pot experiments were carried out with clover, rape and oats in two loams and a clay soil; one of the loams was very rich in sulphur. At the beginning of the experiment, sulphur and lime were applied to the pots, which were watered each day with solutions of various strengths of calcium sulphate and sodium sulphate. A similar series of experiments was conducted in sand to which ferrous extracts had been added. Finally, all the pots were watered every day with a solution of sodium nitrate, so as to prevent nitrogen from being a limiting factor. The experiments lasted 2½ months, when the dry weight of the green parts was determined as well as, in most cases, the total sulphur and nitrogen.

It was found that in the series of pots with earth and those with sand the sulphur led to increased growth, thus showing that the sulphates and free sulphur had a direct fertilising action; again, the sulphates produce increased growth of the roots and the formation of nodules in the clover grown in soil, thus increasing the nitrogen content of that plant.

A new method of destroying the "Leather-Jacket" Grubs of Crane-Flies. *C. M. Packard and B. G. Thomson, U.S. Dept. Agr. Circ.* 172.—In America, as in this country, large areas of pasture land and crops are devastated by the attacks of "Leather-jackets." As many as 300 grubs have been found in a square foot of soil, and on large ranges damage to the amount of thousands of dollars worth of forage, resulting in consequent loss of stock from starvation, has been done in a single year. The Californian "Leather-jackets" which were the subject of experiment, belong to two species of Crane-fly different from those found in this country: but since the habits of the grubs are very similar it is reasonable to suppose that they would succumb to similar methods of attack. Indeed, till the method to be described was discovered, the only means of control was one often adopted in the British Isles, namely the continuous and deep cultivation of the soil.

The observation that the "Leather-jackets" usually came to the surface of the soil at night, and appeared to feed there led to the adoption of a poison bait, with excellent results. A bran mash, similar to that used for destroying grasshoppers was used, consisting of 25 lb. of bran, 1 lb. of Paris green, and water about 3 galls., sufficient to make a flaky mash. The Paris green is mixed *thoroughly with the dry bran, and water added gradually to make a fine uniform* mixture. This is applied, either broadcast or with a horse-drawn grain seeder, at the rate of 10 to 20 lbs. an acre. The result in the experimental plots was uniformly good, an average of over 72 per cent. of the "Leather-jackets" present being killed, and the cost of the mixture, which is about 50 cents an acre, is saved many times over in increased yields of grain and pasture. It is advised that precautions should be taken to prevent the poisoned bait from falling in lumps on the field, and to avoid leaving it in quantity where children or animals can reach it. But in California it has been spread many times where cattle and sheep were grazing, with "absolutely no injury to the stock."

The Habits of the Frit-Fly. *N. Cunliff, Ann. App. Biol.*, 1921.—In various fields at Sandford-on-Thames regular collections were made throughout the year which revealed the presence of Frit-Fly during the whole period, except from the end of October to the end of April. The greatest numbers were caught in July and August, but the author thinks that the periods of high prevalence are limited by meteorological conditions, since high temperatures were associated with large numbers. Observations were made to discover the total period of the life history, and it was found that the number of days between the emergence of two generations varied from fifty days in spring to thirty days in summer, and 230-250 days in winter, while adult flies lived for about fifty days in captivity. In all, there are probably four generations in a year, and these, when oat crops are not available, may breed in a variety of common grasses both in summer and winter. Several experiments were made to determine whether deep ploughing would destroy the Frit grubs, but the author is led to the conclusion that ploughing in a badly infested crop would not be effective. Ploughing would check the development of grubs in their early stages, owing to the destruction of their food supply, but such ploughing would have to be done almost before the grubs had made their presence known. Rolling after ploughing would, on heavy land, probably form a crust too dense for the flies to penetrate on emergence, but on medium or light land it would be ineffective. Nor is much hope to be placed in manuring, for after sundry tests, the author concludes that "nitrogenous manures are not likely to repay the cost of application on average land in England." The paper concludes with a list of parasites which are the natural enemies of the Frit-Fly.

Control of the Cabbage Butterfly. *E. Blanchard, La Vie Agricole et Rurale, Paris.*—An account is given of the methods employed in France in keeping this pest in check. Most of the methods have already been practised in this country with more or less success. They include hand-picking the caterpillars, dusting the plants with quicklime, singeing the caterpillars with straw torches, and spraying with various noxious liquids such as petroleum emulsion and lysol solution.

Mechanical methods of hindering the butterflies from lying their eggs upon the cabbages seem to have met with some success. One of these is the planting of broom branches between the cabbages, and others the planting of hemp and of Jerusalem artichokes. The value of the method lies in that the height of these plants is supposed to cause the butterflies to fly high out of range of the cabbages themselves. As in this country, the most destructive enemy of the cabbage butterfly is the Hymenopterous parasite *Apanteles glomeratus*, and the suggestion is made that the artificial breeding of this natural enemy would probably prove an effective control measure.

Insect Pests of Flax. *G. H. Pethybridge, H. A. Lafferty and F. G. Rhynehart, Jour. Dept. Agr. Tech. Inst. Ireland.*—Three insect pests were found to do a considerable amount of harm to the Irish flax crop of 1920. It was found that flax following oats, which in turn had followed lea, was attacked by the "Leather-jacket" larvae of the Crane-fly. They bit through the young flax stalks and dragged the free portion below ground. Experiments indicated that wire-worms did no serious harm to flax.

The flax flea-beetle (*Longitarsus parvulus*) also fed freely on the plants, the greatest amount of damage being done during August and September by adult beetles said to have been hatched from the pupae of larvae which had rested over winter from the previous year. It is recommended that fields should be treated with ½ cwt. nitrate of soda per acre for young plants, and that after the crop has been pulled the fields should be cultivated and rolled to destroy larvae and pupae.

A Capsid plant bug (*Calocoris bipunctatus*) pierces the stems of flax, and apart from sucking the sap exposes the plant to the attack of a fungus. It is suggested that good will come by ploughing fields not sown to grass, immediately after the flax has been pulled.

Nitrogen Metabolism of Two-Year-Old Steers. *S. Ball and H. S. Grindlay, Jour. of Agric. Research.*—The authors conducted an experiment on metabolism covering a period of thirty-seven weeks at the Illinois Agricultural Experiment Station, upon eight two-year-old steers. Determinations were made of the quantities of nitrogen ingested and excreted and the results are summarised as follows:—

The steers maintained a positive nitrogen metabolism for long periods, when receiving considerably smaller amounts of digestible protein than are usually considered necessary for maintenance.

Curves showing the nitrogen consumption, the total nitrogen excretion, the urinary nitrogen, and the nitrogen balance are more or less parallel.

Steers which received larger amounts of nitrogen stored larger amounts.

The authors state that 14·7 per cent. of the total increase in live-weight was protein. Each steer stores from 18·9 to 25·1 per cent. or an average of 22·37 per cent. of the protein digested. Although the various lots (two animals per lot) were given different feeds, varying from the ordinary maintenance ration to the maximum amount readily eaten by steers and although the proportion of maize in the ration had been increased as the experiment proceeded, and towards the end of the latter, linseed oil meal had been introduced (during the preceding part of the experiment the chief feed was clover hay), the differences in treatment had no effect upon the percentage of protein in the increase of live-weight, nor on the percentage of nitrogen absorbed and retained. As a general rule in every case, there was a decrease in the percentages of protein stored, towards the end of the experiment, but this fact may be attributed to the advancing age of the animals.

Out of 284 nitrogen metabolism records, only five gave negative results.

Comparative Return of Albumen and Carbohydrates. *A. Gouin and P. Andouard, Paris.*—Physiologists are still engaged in discussing the question whether albumen on account of its complicated structure does not require a much larger expenditure of energy in its digestion than starch and sugars. If this be the case, as is maintained by CHAUVEAU, its nutritive return would be considerably diminished. Although the authors' experiments were not undertaken for the special purpose of deciding the matter they yet afford some useful data.

In the many years during which they have drawn up the nutritive balance for calves fed on maximum rations, the composition of the latter was very varied. The nutritive ratio of the feed in some cases varied from 1 to 3·5 and in others as much as 1 to 8.

The amount of the nutritive principles ingested remained, however, always the same, which would seem to show that the digestion of albumen is no slower than than that of carbohydrates. The animals grew as rapidly on the one diet as on the other. The sum of the nutritive principles absorbed in growing and for the maintenance of the body never changed, however much the rations varied.

Numerous experiments with pigs, which, however, were not carried out with the same accuracy, confirmed the results of the experiments on cattle.

In their experimental piggery, they carried out as intensive a system of freeding as possible, the animals from the beginning being given as much as they could eat. The rations consisted entirely of concentrated feeds, often diluted with a little skim milk. The pigs were weighed every week.

For a long time, the authors' thought it best to give the pigs only the full amount of nitrogen required for flesh formation and the reconstruction of waste tissue. The nutritive balances for five consecutive months showed that the animals had never received less than was needed for these purposes. For the rest of their vital expenses, these being by far the most important, they drew with equal success upon the starch or sugars.

In the case of very young animals, the nutritive ratio was as 1 : 5; later, it rapidly widened and ended by being 1 : 10 or even more.

As starchy substances and sugars were not available for stock feeding during the war the authors were obliged to have recourse to two cakes, viz., groundnut cake which contains excess nitrogen and has a nutritive ratio of 1 : 1 at most, and palm-nut cake of which the ratio is 1 : 4·5.

As a rule the pigs did not eat palm-nut cake very readily; in order to induce them to consume the enormous rations required by intensive breeding, it was necessary to mix the cakes, giving half of each. Then the nutritive ratio fell to 1 : 3, when the average with starchy food had previously been 1 : 8. The average daily gain in weight of the twenty-six pigs raised from 1910 to 1916 with this wide ration was as follows :—

Pigs weighing	18 to 30 kg.	605 gm.
Pigs weighing	30 to 100 ,,	720 ,,

or a daily gain, for each pig weighing 18 to 100 kg., of 700 gm. The daily increase in weight of the eleven animals which had to be fed on a very narrow nutritive ratio from 1917 to the beginning of 1920 was as follows :—

Pigs weighing	18 to 30 kg.	536 gm.
Pigs weighing	30 to 100 ,,	718 ,,

or an average gain of 684 gm.

Although when the pigs were very young, lower results where obtained with nitrogen than with starch, the authors are of opinion that no decisive conclusion can be drawn from this fact.

On the other hand, it seems certain that, in spite of the difficulties entailed in the digestion of nitrogenous substances, omnivorous and herbivorous animals alike are able to make use of the same amount of nutritive principles, whether the food contains excess nitrogen, or only the necessary amount, and that the nutritive return is the same in both cases.

These experiments on young animals and these nutritive balances, clearly prove that for the maintenance of the body and provision for growth, the value of albumen is not below that of starch and sugars.

Inheritance of Colour in Jersey Cattle. *J. J. Hooper, Jour. of Dairy Science.*—The author consulted the Registry books of the American Jersey Cattle Club, and tabulated the colour markings of 1145 calves male and female, and of their sires and dams. These indicated that the following were the dominant characteristics; (1) solid colour over mottling; (2) black tongue over white; (3) black switch over white. There was a marked tendency towards the combination of the characteristics solid colour, black tongue and black switch. The roan colour which was hitherto fairly common amongst Jerseys was apparently dominant to the ordinary colour.

Uterine Disease in Cows, the extent to which it is due to the Bang-Stribolt Bacillus. *S. Rivabella, La Clinica veterinaria.*—Inflamation of the uterus is one of the most common causes of sterility and abortion in domestic animals. In order to diagnose the symptoms with certainty and accuracy the author proposes a cytological examination of the uterine secretion collected *in vivo* from the animal with special precaution and according to a new method.

In the present article, the author describes a series of experiments made for the purpose of comparing the results of his method of diagnosis with those of methods based exclusively upon bacteriology and serology, in order to determine whether the lesions of the uterus are always accompanied by the Bang-Stribolt bacillus.

Out of more than 100 cows examined, seventy-six were proved by cytological examination of the uterine secretion to be suffering from disease of the uterus.

This diagnosis was confirmed in the case of some cows by means of microscopic examination, and in that of others by careful observation of the symptoms. Of these seventy-six cows, only ten gave a positive result to the agglutinaton test for the Bang-Stribolt bacillus. Thus, it would appear that this micro-organism is the cause of uterine disease in only a very limited number of cases.

This supposition agrees with the observations of Prof. STAZZI upon the distribution and gravity of cases of abortion and vaginitis in the various regions of Italy. He noticed that epizootic abortion due to the Bang-Stribolt bacillus is a disease peculiar to large farms, where cattle breeding is intensive, and the animals are kept in the sheds and stall-fed throughout the year.

Ox-Warble Prevention. *M. Imes and F. L. Schneider, Jour. Am. Vet. Med. Ass.*, 1921.—Cattle were dipped and sprayed without seriously affecting the prevalence of ox warbles; but it was found that where cattle had been protected from the egg-laying of the fly, by having their legs below the knees and hocks coated with a protective solution during the fly season, then the winter crop of warbles was much reduced. The most effective fluid was a 2 per cent. solution of creosote, and the general indication of the experiments was that the passing of the cattle through a wading tank containing such a solution gave effective protection.

The Blow-Fly Pest on Sheep in Australia.—Several references have been made in these pages to the damage caused by sheep-maggots in Australia, and to the means by which control of the pest has been attempted. Notwithstanding all efforts there appears to be no diminution in the damage done, and two important papers in the *Queensland Agric. Journal*, for June 1921, show that more and more drastic remedies are being tried. The annual loss of sheep is now reckoned at about 5 per cent. The Blow-Fly Committee of the Commonwealth Institute of Science and Industry has given attention particularly to the checking of Blow-Fly ravages in the flocks, and after treatment of a flock of 14,000, has come to the conclusion that temporary but complete immunity from attack may be obtained by spraying the hind quarters of sheep with strong mixtures of arsenic with various solutions such as sheep-dip and oil. The amount of arsenic now used would once have been regarded as fatal, one experimenter using up to 10 lb. of arsenic to 100 gallons, though he does not recommend this strength for general use. The mixture is applied with a mechanical spray at a pressure of 100 to 120 lbs. Sheep so sprayed are immune from attack for three or four months, and one man may treat over a thousand sheep a day.

The second paper by Mr T. H. Johnstone, points out that measures aiming at the direct protection of the flocks are troublesome since they have to be repeated year after year, and that they do nothing to reduce the numbers of the pest itself. The author has more faith in encouraging the numbers of those insects which are enemies of the Blow-Flies and destroy their larvæ or pupæ by parasitising them. If parasites sufficiently widespread and active enough to ensure a marked reduction in the numbers of Blow-Flies are not to be found in Australia, he advocates the introduction of suitable parasites from the British Isles.

Sheep Mange Treatment. *A. Nagler, Berlin Tierarztl Wochenschr.*—Fumigation, proved to have been successful in the destruction of many insect pests, has been tried with good effect in treating mangy sheep. The sheep, four at a time, are placed in a wooden gas-tight chamber, so arranged that the heads of the sheep project into the open air through close-fitting gas-tight collars. The wooden case is then filled with sulphur dioxide (SO_2) to a strength of 6 to 8 per cent., and after immersion for some forty minutes, on two occasions within a period of five days, the sheep are found to be entirely free from living mites and their eggs. The advantages claimed for the method are that it is easy of application, that the sheep need not be shorn, that forty-eight sheep can be dealt with in ten hours, that it is cheaper than any other method, and that it is thoroughly effective.

Feeding Fowls on Ground Nut and Palm Oil Cakes. *A. Gouin, Jour. d'Agric. partique.*—For twenty-five years, the author has been giving his fowls (which he keeps in a pen), cakes with a high nitrogen content, and for the last four years, he has fed them exclusively on this fare, consisting of ⅓ groundnut cake, and ⅔ palm-oil cake. The birds never get grain of any sort, the only addition ever made to the cakes being a little bone-meal. Each fowl consumes daily just under 100 gm. of the mixture, the daily ration costing six centimes. As twenty-five fowls lay on an average, ten eggs a day, the net cost of the eggs is fifteen centimes each. The quality of the eggs leaves nothing to be desired.

Further, these nitrogenous cakes make the birds grow more quickly than the other, dearer foods usually given to poultry (wheat, buckwheat, rice, bran, potatoes).

Ducks also greedily eat groundnut and palm-oil cakes, and grow very rapidly when fed on them.

Early Laying of a Black Bresse Hen. *La Revue avicole.*—Mme. M. L. BRUN, member of the Central Avicultural Society of France, mentions a case of extraordinarily early laying on the part of one of her pullets. The bird, which belonged to the black Bresse breed and was hatched on 12th April, laid its first egg on 8th July, that is to say, when less than three months old. This egg weighed 35 gm., and those the bird laid afterwards weighed as much as 37 gm. At the end of October, the fowl had already laid fifty-two eggs.

Experiments with, and Practical Application of, Heat Sterilisation for All Parts of Milking Machines. *G. H. Hart and W. H. Stabler, Jour. of Dairy Science.*—A great many experiments have been initiated to ascertain the mechanical difficulties and the relative production that can be secured with the use of milking machines, as compared with hand milking. The authors have, however, devoted their attention to ascertaining the best method of eliminating excessive numbers of bacteria in machine-drawn milk. They mention the most important works already published on bacteria in machine drawn milk and the use of various sterilising agents. Results are then given of tests carried out by the authors with C. H. McCHARLES (Chemist of State Food and Drug Laboratory) to show the reduction in chlorine content by oxidation in the presence of milk or rubber.

The tests show that both milk and rubber reduce the chlorine content of solutions containing it and the more milk residue that adheres to the tubing, the quicker the chlorine becomes utilised.

The original plan of sterilisation of the parts, in the dairy in question, was to put the tubes and teat cups in a low pressure steam steriliser, but depreciation of the rubber was rapid: the authors installed instead a galvanised iron tank 4 feet long 1 foot wide and 1½ feet deep, without any lid, and the parts were placed in water in the tank and the temperature raised by steam to between 160 and 180 F. for fifteen to twenty minutes.

Tests were conducted by running sterile water through the apparatus to be tested. The amount of water used in each test was 100 cc.

Milk counts over seven days showed that sterilisation was sufficient to produce a milk well under 25,000 bacteria per cc., the limit for the grade.

The tinware on the ranch is regularly sterilised in an autoclave under pressure. In all, 113 samples of machine-milked milk was collected and counted: two samples were over 10,000, and the highest being 18,000.

The general superiority and efficiency of heat sterilisation is demonstrated and it is shown to be the only way to sterilise successfully milking machine rubber parts under ordinary ranch conditions. Where it has been regularly done, no increased trouble with mammitis has ever developed as a result of installing machines, and as low a bacterial count can be produced with milking machines as by hand milking. No chemical solution has been found successfully to accomplish these results under practical conditions.

Damage of Seeds in Threshing. *G. Martinet, Lausanne.*—According as the season is more or less dry, the proportion of grains of wheat that are broken or simply cracked by the thresher is fairly large and not only leads to wastage but to deficient germination and plants that come up too thinly. The splitting of the grain is only detected when it is treated with copper sulphate, as the fissure stains blue. Split grains are obviously not sieved out in the machine and the large grains are those most likely to suffer.

When cereals were threshed with a flail, the cut wheat was left to ripen and dry in the field, particularly oats, which were often left two or three weeks, the aim being to facilitate separation of the seed. The need for reducing the cost of harvesting has led to the neglect of this practice and the crop is too often brought in too early, before the straw is sufficiently dry, especially at the nodes. The remaining damp causes the heap to ferment too much, thus spoiling the seed, not only in the case of oats, but also with naked seeds.

As the crop is not sufficiently dried, the action of the organs of the threshing machine has had to become more vigorous in order to separate the seed completely. Consequently the drum has to revolve more quickly and the fittings of the drum and counter-drum are closer set. The beaters themselves, which were formerly wooden staves cased with iron or angle irons whose ridge was the sole active part, have given place in the modern drums to beaters with oblique, very prominent grooves, so that the thresher would be almost like a crusher did not the presence of the straw somewhat mitigate the violent action of the shelling organs on the grain.

The " English " beaters are suitable for wheat with soft seeds, but not hard or semi-hard seeds. In fact some recent threshers of English make have beaters with less pronounced undulations and with the front part bevelled, and, in addition, the beater is often preceded by an inclined plane which pulls the straw and ears less roughly towards the beater. In this respect, the angle iron, and to a certain extent the closed drum, act more or less in the same way.

The French makers fit the working part of the beaters in their machines with iron bands with fairly smooth longitudinal undulations, so that breakage is diminished or hardly occurs.

The makers, therefore, should study the subject, so as to avoid useless damage to the grain and straw. The author thinks that the French beater with an inclined plane is the type that should be adopted.

In threshing seed grain it might be useful to adopt a light pre-thresher, with soft wooden beaters, which would separate the large grains for use as seed and would be followed by complete threshing with the ordinary drum placed immediately afterwards.

A Tractor with the Greatest Possible Grip. *R. Dessaisaix, Jour. d'Agric. Pratique.*—In order to obtain the greatest possible effort of traction from a tractor, it has been attempted to make all the wheels propulsive. For several years tractors of this kind have been suggested in Great Britain, France, America, and Italy.

A new model, the VALERE CHOCHOD, was shown during the Semaine d'Automne de Chartres, by the CARTOUCHERIE FRANCAISE DE SURVILLIERS (Seine-et-Oise). The 4-cylinder engine, running on oil, 90 mm. in bore and 150 mm. stroke, develops 20 to 24 H.P. at 1100 revs. per min. A pulley below the radiator provides a belt drive for other machinery.

The four driving wheels are 40 inches in diameter, the tyres, 1 inch thick, are fitted with grips and the two wheels on each side are actuated by an enclosed chain drive.

Through the gear box the engine drives shafts which can be geared up to each wheel separately, each wheel actuating through a chain, the corresponding wheel running loose on the other axle. Thus the two wheels correspond to the chain-tracks of a caterpillar tractor. Steering and turning is done though levers which brake the wheels on one side while the other turns. The weight of the tractor in about 2½ metric tons, the maximum and draw-bar pull is 1300 kg.; the ratio of these two figures gives a coefficient of 0·52.

The tractor is provided with two driving seats facing each other, so that there is no need to turn the machine round at the end of each furrow. The two speeds are 3500 and 4500 metres per hour and there is a reverse.

Continuous Knife Mowers. *P. Laure, La Vie Agricole et Rurale.*—The mower knife works with an interrupted movement, the grass being cut by the action of the blade edge passing between the teeth of the comb. The action is similar to that of pruning shears, and needs more power and is not as clean as that of the double-blades of garden shears or tinman's shears. But a satisfactory movement of the blades of the shears in the grass is not practicable.

M. J. d'HEUR, of Daubs (France), has evolved a set of continuous action shears. To do this, he replaced the toothed cutter by a blade having steel teeth set "en echelon" and with vertical cutting edges. Two blades, moving in opposite directions one over the other, act as clippers, cutting the grass.

Continuous movement is obtained by using an endless steel band, a sort of bandsaw whose parallel blades move in the space between the combs used in the machine. The band passes over a small pulley at the end of the knife blades and is actuated by another pulley driven off the road wheel of the machine.

A lateral roller assures the stability of the machine.

A single driving wheel is found to be very efficient and does away with the need for a differential.

A Seated Drag-Hoe. *P. Larue, La Vie Agricole et Rurale.*—In classical machinery for cultivating the soil, the working parts slid through the earth, the machine was carried on wheels and the driver walked behind.

M. BAILOR has constructed a tillage machine in which the working parts rotate, the supports slide and the driver sits.

The whole machine represents a small disc harrow mounted on two runners with a steering runner behind. The depth is regulated by means of a lever held by a ratchet.

Oblique weeder blades in front give stability and prepare the work for the discs.

Broom as a Papermaking Material. *E. Blin, Jour. d Agric. Pratique.*—M. ARDOUIN-DUMAZET has recently drawn attention to the possibility of utilising broom (*Sarothamnus scoparius*) as a paper-making material. N. ROGER took up this question in 1903, and the investigations made also by the author in 1912, 1913 and 1914, and the communication which he received from Prince BORGHESE with respect to the trials conducted in Italy, have led him to the conclusion that the attention of farmers and manufacturers should be directed towards this use of broom.

The author first deals with methods of cultivation, a matter which should be considered, as the production from wild plants would be insufficient.

As regards sowing, the seed should be collected before it is ripe and left to dry in a well ventilated place. In the spring the seed should be sown very thinly in a field of oats, and in small holes 1 m. apart, putting two or four seeds in each hole. Later the seedlings are thinned out to one plant per hole. In the spring of the third year, the plants are cut back to a height of 30 cm., to encourage sucker growth; the numerous branches which thus develop are cut each year and utilised for industrial purposes.

It is possible to obtain 10,000 plants per hectare in this way and to cut as many as three times from the second year onwards with a constant yield for twenty years. According to the data recorded in Italy, the average yield per annum is from 200 to 230 quintals per hectare. It is estimated that 12,000 quintals of green broom yield 6000 quintals after drying, and that this quantity will provide 4200 quintals of paper pulp.

After drying and dressing, the dried broom is passed into a cold, alkaline bath containing either a mixture of sodium carbonate and milk of lime, potash, or some other alkaline substance in suitable proportions to give the same results as the caustic soda. After three or four days, the disaggregated branches are taken out of the bath, carefully washed and put into another

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bath containing 1 to 2 per cent. chloride of lime. The stems remain in this bath for two or three days until they become very soft: they are then taken out and plunged into a cleansing bath containing a small quantity of sulphuric acid or sodium hyposulphite.

After this treatment, the broom is crushed in order to obtain the required fineness of pulp.

The liquid from the baths containing either alkaline soda, potash or other alkalis, retains the chlorophyll and dissolves the gums and resins, a part of which is saponified and a part set fee. By adding fats or oil to this liquid, a good-quality soap may be obtained. In short, the manufacture of paper according to this method includes the following operations:—Cutting, beating, soaking for six to seven days: further grinding, expression in a hydraulic press (to eliminate water, chlorophyll and other by-products): separation and washing in the so-called "Hollandaise No. 2" machine, and finally grinding.

To treat sixteen to twenty quintals of dried broom in one day, and obtain a yield calculated at twelve to fourteen quintals of paper pulp, the following plant is necessary:—two cutters, three cylinder crushers, two hydraulic presses, four "Hollandaise" machines, and two grinding machines.

Apart from the residue formed in the alkaline liquid, the infusion leaves a definite residue composed of chlorophyll and gum which will yield 38 kg. of good-quality soap per quintal of pulp.

Considering that with maceration and steeping, a yield of as much as 75 per cent. is obtained from fibrous vegetable materials (straw, bamboo, etc.), it is evident that the utilisation of broom as a source of pulp supply constitutes a valuable supplement to forest trees whose exploitation will only be possible after a considerable time.[1]

Bee-Keeping in Isolated Hives. *Robert Aubert, L'Apiculture.*—Bee-keepers, whose stock is attacked by foul-brood, are usually those who take their honey too early and use composite hives arranged in such a way that they always obtain relatively large quantities. Taking the honey and replacing the frames of these hives for the bees to clean are two operations that encourage the queen to lay at the very time when she ought to be prevented from so doing. If the honey supply continues, no harm is done, but if the honey-season is finished, which is generally the case in districts where foul-brood is rife, there is a great risk that the bees seeing their emptying frames, will let part of the brood die on account of want of honey.

The author has substituted for this pernicious system one which twenty-five years' experience has proved most satisfactory. He uses LAYENS hives with twenty, twenty-two and twenty-five frames. In May, he pays his first visit, cleans the hives, divides any food that is left, and replaces useless frames with sections containing bees-wax. Having done this, he does not open the hives again until after 1st September, unless the season is a good one, in which case, he visits them again, to take the honey from the side opposite the brood. This operation takes place once every three years. In September, he removes the superflous honey, and as the bees only concern themselves with the part of the hive where they are going to winter, this hardly disturbs them at all, and the replacing of the frames to dry only gives them one day's work.

The result of twenty-five years' bee-keeping with isolated hives according to this simple method is that the honey supply has never failed and the author has taken honey every year. The average yield in Oise during these twenty-five years was from 22 to 25 kg., per hive per annum. His great triumph is that, even in bad seasons, it has never been necessary to feed the bees. The latter were thus allowed to live naturally, they received no food, the brood did not die, and there was no signs of foul-brood.

M. ROBERT-AUBERT is of opinion that if all bee-keepers followed his example, many more hives could be kept and much larger quantities of honey obtained without losing the brood. Bee-keepers who take too much honey, whose broods die, and who are obliged to feed their bees on a large scale every year, are evidently in the wrong.

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[1] Another species of broom (*Spartium junceum*) has been used as a paper-making material.

OFFICIAL ORDERS AND CIRCULARS.

THE following circular was issued in December :—

Scheme for Land Improvement and Drainage Work for the Unemployed.

Drainage.

1. In order to provide work for the unemployed in districts where serious unemployment exists the Board of Agriculture for Scotland have been authorised to provide financial assistance for the execution of works for Land Improvement and Drainage. A limited amount of the funds will be applicable to field and arterial drainage and land reclamation. As the object in view is to meet immediate unemployment, applications should be made (in accordance with paragraph 8) without delay.

2. The Board are prepared to defray half the cost of approved works, the proprietors bearing the other half, but in no case shall the Board's contribution exceed £10 per acre for field drainage. Applications from tenants for assistance in field drainage will be considered upon the same basis. Subject to the condition that the essential object of the Government contribution is to provide relief for unemployment, the Board will give a preference to cases in which the proprietors or tenants of adjoining lands combine for the purpose of carrying out a co-ordinate scheme of drainage, including the improvement of water courses which are of common interest to the lands concerned.

3. Work should be done as far as possible by hand labour so as to absorb the maximum number of unemployed men.

4. The Board's contribution will only be paid in respect of works carried out by means of unemployed labour obtained as stated in Paragraph 5.

It is expected that where possible the work will be undertaken entirely by unemployed labour. If any regular skilled men are employed for the purpose of supervision or otherwise the number should be the barest minimum and the Board will require to be satisfied that the wages of the additional unemployed men engaged in accordance with Paragraph 5 amount to a sum at least equal to the Board's contribution.

5. Labour must be obtained through the Labour Exchange or must be composed to the extent of 75 per cent. of unemployed ex-service men. So far as civilians are engaged a majority must be married men, if available.

6. The wages paid must not exceed the current rates of unskilled agricultural labour in the district or 75 per cent. of the current rate for adjacent urban unskilled workers

7. Works in respect of which grants would be made should normally be completed by about the 31st March 1922.

8. Forms of applications for Grants may be obtained from the Board or from the Local Authorities. They will contain an undertaking to be signed by the applicant that he will complete the proposed works to the satisfaction of the Board.

9. The applicant will complete the form in duplicate and transmit both copies, together with relative plans in duplicate to the Local Authority who will scrutinise the application from the point of view of the labour proposals and make any observations on these and otherwise on the application as the Local Authority may consider appropriate.

10. The Local Authority will then forward the application to the Board who will scrutinise it from the technical aspect as they think fit.

11. The Board on approving an application will intimate approval simultaneously to the Local Authority and the applicant ; returning to the latter one copy of the approved application with plans and to the Local Authority a copy of the application.

12. Applications for advances of a payment of grant shall be forwarded by the applicant to the Board through the Local Authority who will be required to certify that the conditions set out in Paragraphs 4, 5, and 6 have been complied with.

13. "Local Authority" in this Memorandum means the County Council. County Councils should, however, keep in touch with Town Councils in order that the question of engaging unemployed men resident in Burghs as well as in the landward area may be considered.

The following circular which was issued to the press in December gives a summary of the regulations relating to the export and import of seed potatoes.

Seed Potato Regulations.

Potatoes.

The Board of Agriculture for Scotland desire to remind all farmers and potato dealers of the regulations which are in force relating to the sale, exportation and importation of seed potatoes.

To meet the requirements of the Seeds Act, 1920, and the Seeds (Scotland) Regulations made thereunder, a declaration must be made in the case of a sale or exposure for sale of seed potatoes stating their class, variety, size and dressing.

All potatoes grown in Scotland must be described as "Class I (Scotch)." With regard to variety, this shall not be held to be incorrectly stated if it is true in respect of 97 per cent. of the total quantity sold or exposed for sale. In this connection, however, a general licence has been issued reducing this standard for the current season only to 95 per cent. The requirement as to "size and dressing" means that a statement must be made of the size of the mesh (exclusive of the thickness of the wire) of the riddles through and by which respectively the potatoes may be passed and retained. In the case of a sale for seed purposes of potatoes as grown, the size of the mesh of the top riddle need not be stated if the written description "as grown" is given.

The following is a summary of the regulations governing the exportation and importation of potatoes from and into Scotland :—

EXPORT TO ENGLAND AND WALES.

The use for seed purposes of potatoes imported into England and Wales from Scotland is prohibited unless the sender furnishes the consignee with :

(*a*) In the case of certified stocks of the immune varieties, the serial number of the certificate of purity issued by the Board in respect of the growing crop : or

(*b*) In the case of all other potatoes (including stocks of the immune varieties not certified as to purity), the reference number of a certificate obtained from the Board to the effect that Wart Disease has not occurred on or within one mile of the land where the potatoes were grown.

EXPORT TO IRELAND.

The landing in Ireland of any potatoes (both seed and ware) grown in Scotland is prohibited unless the consignment is accompanied by a declaration by the sender on the form prescribed for the purpose stating :

(*a*) The reference number of a certificate obtained from the Board that the land on which the potatoes were grown is situated outwith any of the districts declared to be Wart Disease "infected areas" and not less than one mile from any infected land ; and

(*b*) In respect of stocks of the immune varieties, the serial number of the certificate of purity issued by the Board after inspection of the growing crop. Stocks of the immune varieties not certified as to purity are not allowed entry into Ireland.

EXPORT ABROAD.

In most of the colonies and foreign countries restrictions are imposed on the admission of potatoes necessitating the production of official certificates as to their freedom from diseases.

IMPORT INTO SCOTLAND.

No potatoes grown in the districts in Ireland known as the "Black Scab areas" may be imported into Scotland, and seed potatoes from England and Wales can only be imported under the authority of a licence from the Board.

Under the provisions of the Destructive Insects and Pests (Scotland) Order of 1921 which will come into operation on the 1st January next, potatoes imported from abroad with the exception of new potatoes landed on or before 31st July in the year in which they are harvested, and of consignments from the Channel Islands will be detained at the ports of landing unless they are accompanied by an official certificate issued in the country of exportation that they are healthy and free from injurious diseases and have not been grown within 500 yards of land infected with Wart Disease.

Any person desiring fuller information with regard to existing regulations should apply to the *Secretary*, *Board of Agriculture for Scotland*, 29 *St Andrew Square*, *Edinburgh*.

The following circular letter was issued by the Board to the Local Authorities of Seaport Towns in Scotland:—

The Rats and Mice (Destruction) Act, 1919.

Destruction of Rats.

SIR,—I am directed by the Board of Agriculture for Scotland to state that they have had under consideration the question of the destruction of rats on vessels at Scottish Ports. Section 6 of the above Act provides that:—

(1) This Act shall apply to a vessel as if the vessel were land, and the master of the vessel shall be deemed to be the occupier thereof;

(2) A local authority having power to enforce this Act may, by notice served on the master of a vessel in its district, require him to take such necessary and reasonably practicable steps as are prescribed by the notice for preventing the escape of rats and mice from the ship, and if a master fails to comply with the requirements of any such notice served on him, he shall be liable on summary conviction to a fine not exceeding twenty pounds.

In view of the damage caused by rats and mice which are usually present in large numbers on most ships and in order to prevent their escape to land when the ships are in port, the Board desire me to submit the following suggestions for the consideration of your Council:—

(1) That public notice should be made at prominent places in ports emphasising the statutory duties of the master of a vessel and the penalties for non-observance thereof. Particulars should also be given in the notice of the most effective methods of destruction of rats on vessels. In this connection I am to enclose herewith for your information a copy of a report prepared by Dr W. M. Willoughby of the Port of London Sanitary Authority; in addition to the suggestions contained therein the Board would recommend that ship-masters should be required to have rat-guards attached to the mooring ropes of vessels in port;

(2) That a person should be authorised by your Council in terms of Section 5 (4) of the Act to enter on and inspect vessels immediately on their arrival in port. If a vessel is found on examination to be invested a notice should at once be served upon the master in terms of Section 6 (2) of the Act, and an inspection of the vessel should subsequently be made in order to ascertain whether the necessary steps have been taken by him to implement the requirements of the notice;

(3) That suitable arrangements should be made for dealing with cases of default.

In this connection, however, it is improbable that many shipmasters will have at their disposal the means or appliances necessary. Your Council might consider, therefore, whether a scheme could be devised whereby the work would be undertaken by one of your officials on payment by the shipmaster of a sum fixed according to tonnage, etc.

The Board would be obliged for the favour of the observations of your Council on the foregoing suggestions. They would be glad to learn particularly whether any such arrangements are already in operation within the area of your Authority and, failing that, whether it is proposed to adopt measures.

I am, Sir,
Your obedient Servant,
CHAS. WEATHERILL, *Secretary*.

Live Stock.

Maintenance of Live Stock (Scotland) Order, 1920.—This order was revoked on 11th October 1921. Restrictions on the slaughter of pregnant cows, sheep and swine are thus removed.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in September, October and November 1921.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	September. 1st.	September. 2nd.	September. 3rd.	October. 1st.	October. 2nd.	October. 3rd.	November. 1st.	November. 2nd.	November. 3rd.
FAT STOCK:—									
CATTLE—	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*	per cwt. l.w. *s.* *d.*
Aberdeen-Angus	89 8	81 11	55 8	83 7	74 5	51 2	79 2	69 9	46 11
Shorthorn	86 9	80 9	55 0	78 3	71 3	50 0	72 10	64 10	47 5
Galloway	75 6	69 9	62 9	66 4	60 8	55 8	62 7	58 0	53 2
Ayrshire	69 11	51 6	34 3	61 9	43 3	20 0	60 6	52 10	20 0
Cross-bred	84 11	76 6	55 0	78 5	70 1	47 4	73 8	65 0	45 3
Blue Grey	82 5	76 3	61 0	66 6	60 8	55 6	62 8	58 0	53 2
Highland	82 8	76 0	52 0	64 0	...	50 0	75 3	68 3	42 6
	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
VEAL CALVES	18¾	10¾	8½	18	9¾	7¼	17¼	9½	7¼
SHEEP—	under 60 lb. per lb. *d.*	60 lb. and upw'ds. per lb. *d.*	Ewes per lb. *d.*	under 60 lb. per lb. *d.*	60 lb. and upw'ds. per lb. *d.*	Ewes per lb. *d.*	under 60 lb. per lb. *d.*	60 lb. and upw'ds per lb. *d.*	Ewes per lb. *d.*
Cheviot	17¾	16½	12¼	14	12½	10¼	13½	12¼	9¾
Half-bred	17½	16¼	10	14½	13¼	9¼	13½	12¼	9¼
Blackface	16¾	15½	13	13¼	12¼	10¼	12¼	11	9¼
Greyface	17¾	16½	12½	15½	14	11¼	14	12¾	9¼
Down Crosses ...	17¼	16½	...	15	14	...	13¾	13	...
PIGS—	per stone. *s.* *d.*	per stone. *s.* d.	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*
Bacon Pigs	17 6	15 9	10 9	14 9	12 11	9 9	13 5	11 4	8 11
Porkers	18 0	16 7	11 2	15 4	13 3	9 9	13 11	11 11	9 0

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	September.						October.						November.					
	1st.		2nd.		3rd.		1st.		2nd.		3rd.		1st.		2nd.		3rd.	
STORE STOCK :—																		
STORE CATTLE—	per head.		per head.		per head.		per head.		per head.		per head.		per head.		per head.		per head.	
Aberdeen-Angus :	£	s.	£	s.	£	s.	£	s.	£	s.	£	s.	£	s.	£	s.	£	s.
Yearlings	29	12	21	13	16	0	22	14	18	5	13	3	19	15	16	5	13	10
Two-year olds ...	38	15	30	12	28	12	34	0	26	13	24	0	30	7	24	15	19	13
Shorthorn ?																		
Yearlings	...		...		...		20	5	17	3	12	10	16	10	14	10	...	
Two-year-olds ...	34	10	32	5	30	0	30	13	26	12	24	18	25	18	23	0	20	0
Galloway:																		
Yearlings	19	0	16	10	13	10	21	5	17	3	14	0	17	0	15	12	12	4
Two-year-olds ...	35	0	26	0	22	0	29	10	25	0	19	7	27	10	22	10	18	4
Ayrshire :																		
Yearlings	14	0	10	5	...		13	8	9	15	8	0	12	9	10	13	11	0
Two-year-olds ...	...		...		.		20	18	15	15	...		23	5	15	15	...	
Cross-bred :																		
Yearlings	21	15	17	1	13	1	21	3	17	2	12	19	19	4	15	8	12	12
Two-year-olds ...	35	4	27	15	22	10	31	14	25	18	20	17	28	6	23	6	18	15
Blue-Grey :																		
Yearlings	19	10	16	0	14	0	22	13	17	13	14	13	...		...		..	
Two-year-olds ...	35	0	26	0	...		30	0	25	13	20	0	32	0	25	0	20	0
Highland :																		
Yearlings	13	0	10	10	7	10	12	14	9	11	7	3	11	18	9	11	6	12
Two-year-olds ...	24	0	19	0	15	10	19	11	16	17	14	9	19	3	16	6	14	14
Three-year olds ...	29	0	25	0	...		29	4	24	1	18	10	28	5	23	0	19	10
DAIRY COWS—																		
Ayrshire :																		
In Milk	46	1	29	8	16	17	44	10	27	13	17	11	45	5	30	17	19	8
Calvers	45	4	29	13	19	11	46	8	27	19	18	14	47	10	30	8	20	0
Shorthorn Crosses :																		
In Milk	56	12	43	8	31	14	52	15	41	0	28	17	50	4	39	7	25	15
Calvers	52	19	37	3	25	14	46	19	35	19	24	7	46	19	34	2	23	2
STORE SHEEP—	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Cheviot Hoggs ...	81	8	67	2	45	0	60	5	45	11	35	0	58	0	34	0	20	0
Half-bred Hoggs ...	114	8	93	5	80	0	92	8	70	0	...		62	6	46	0	...	
Blackface Hoggs ...	58	11	50	5	40	6	36	4	36	2	31	6	42	6	33	5	28	0
Greyface Hoggs ...	85	3	66	6	48	0	70	6	55	0	...		...		...		...	
STORE PIGS—																		
(6 to 10 weeks old)	55	7	34	8	...		40	1	24	8	...		36	6	22	6	...	

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	September.			October.			November.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
BEEF:—										
Home-fed—										
Bullock or Heifer ..	1	13½	14¼	14⅝	12	12⅞	13⅝	11	10⅝	13⅛
	2	12¾	11⅞	13⅜	11	9⅞	10⅛	10	9	12⅛
Bull	1	12½	11½	11	10¼	10⅜	10¼	9¾	9¼	9¼
	2	11½	9½	10	9¾	9¼	9	8¾	8¼	8⅜
Cow	1	10	8¾	10	8	8	8¼	7¼	7½	7¾
	2	7⅞	7½	8⅞	6½	6⅞	7¼	6⅜	6¾	6⅜
Irish—										
Bullock or Heifer ...	1	...	...	12⅛	...	...	10⅜	...	.	9⅜
	2	...	...	11⅜	...	...	9¾	...	..	8¾
Bull	1	...	...	10¼	...	...	8¾	...	...	7¾
	2	...	...	9¼	...	...	8	...	...	7⅛
Canadian—										
Killed at Glasgow ...	1	...	...	11⅞	...	...	10¼	...	...	9½
	2	...	...	11¼	...	...	9¾	...	...	9
Argentine Frozen—										
Hind Quarters ...	1	9½	9⅜	9⅛	...	8⅝	...	...	7⅝	7½
	2	...	...	...	.	..	...	...	...	...
Fore ,, ...	1	5½	5⅜	5¼	...	5¼	...	..	5⅜	5⅜
	2	...	...	...	...	..	...	...	...	5¼
Argentine Chilled—										
Hind Quarters ...	1	...	10	9⅝	...	8⅛	7½	...	8¼	7¾
	2	...	...	...	...	..	7	...	...	7¼
Fore ,, ...	1	...	5¾	5⅜	...	5¼	4¾	...	5⅜	5¼
	2	...	...	...	...	..	4½	...	...	5
New Zealand Frozen—										
Hind Quarters ...	1	...	. .	6½	...	...	6¾	...	...	5⅞
	2	...	...	...	...	...	...	...	...	5½
Fore ,, ...	1	...	...	4¼	...	...	4⅛	...	...	4
	2	...	...	...	...	...	4	...	...	...
Australian Frozen—										
Hind Quarters ...	1	...	...	6	..	...	...	...	...	5½
Fore ,, ...	1	...	...	..	...	...	...	..	...	4½
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	18⅝	14⅞	14¼	16	12⅞	12⅝	13⅛	10⅞	11¾
	60 lb. and over.	17⅜	14⅛	13⅝	15	11⅝	11⅜	12¼	10	11
,, Cross	under 60 lb.	19⅝	15⅝	14¼	17	13⅞	12¾	13¼	11⅞	11¾
	60 lb. and over.	18⅝	14½	13⅜	16	12¼	12	12¼	10¾	10⅞
Ewes, Cheviot ...	1	15	10⅛	10½	11	8¾	8⅞	9½	8⅜	8⅜
	2	14	...	10	10	...	8¼	8½	...	7⅞
,, Blackface ...	1	15	...	10⅜	11	...	8¾	9¾	...	8½
	2	14	...	10	10	...	7¾	8¾	...	7⅞
,, Cross	1	12¾	8⅞	10⅜	9	8	8⅝	8½	7⅞	8⅝
	2	10¾	...	...	8	...	8⅛	7⅛	...	7⅞
Argentine Frozen ...	1	..	7¾	6½	..	6¼	6¼	...	5⅞	5⅞
	2	..	...	...	...	...	6	...	5½	5¼
LAMB:—										
Home-Fed	1	19¾	17¾	15¾	17¼	14	14⅝	13¼	...	12¾
	2	18¾	17	14⅜	16¼	12½	13⅝	...	...	12
New Zealand Frozen	1	14	13⅛	13½	...	10½	10½	...	9⅝	9½
	2	...	...	13	...	...	...	...	...	8
Argentine ,, ...	1	14	..	...	...	9¼	...	...	8¾	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	Sept.		Oct.		Nov.	
		s.	d.	s.	d.	s.	d.
BUTTER:							
Irish Creamery... per cwt.	1	212	0	194	0	204	5
	2	194	8	187	0	190	0
" " (Unsalted) "	1	219	0	200	6	209	7
Canadian ... ... "	1	227	6	210	0	198	0
" (Unsalted) "	1	227	6	210	0	198	0
Danish ... ... "	1	235	6	239	0	239	7
" (Unsalted) "	1	241	0	243	8	239	7
Australian ... ... "	1	210	3	190	0	170	0
" (Unsalted) "	1	210	3	190	0	170	0
New Zealand ... ... "	1	230	3	210	0	196	0
" (Unsalted) "	1	230	3	210	0	196	0
Argentine ... ... "	1	200	0	170	0	163	0
" (Unsalted) "	1	200	0	170	0	163	0
CHEESE:							
Cheddar ... ... "	1	115	6	101	0	100	7
	2	104	0	92	6	92	7
Cheddar Loaf... ... "	...	...		...		...	
Dunlop ... ... "	1	115	6	101	0	97	2
	2	102	6	88	6	88	0
Canadian ... ... "	1	111	6	106	0	102	5
	2	108	6	104	0	96	0
New Zealand (Coloured) "	1	110	9	98	0	88	6
" (White) "	1	111	6	96	0	91	0
BACON:							
Ayrshire (Rolled) ... "	1	233	0	191	9	168	10
Irish (Green) ... ... "	1	191	3	166	6	138	10
" (Dried or Smoked) "	1	211	3	189	0	154	5
" (Long Clear) ... "	1	220	0	175	0	143	7
Wiltshire (Green) ... "	1	191	3	166	6	138	10
" (Dried or Smoked) "	1	211	3	187	0	154	5

Description.	Quality.	Sept.		Oct.		Nov.	
		s.	d.	s.	d.	s.	d.
BACON *(continued)*:							
American, Long Clear Middles (Green) per cwt.	1	124	0	114	6	106	0
American, Short Clear Backs ... ... "	1	112	6	108	0	90	0
American Sides ... "	1	109	0	99	6	79	5
" Cumberland Cut "	1	111	0	101	6	90	0
	2	109	0	99	0	...	
Canadian, Sides ... "	1	131	3	128	3	111	0
Danish, Sides ... "	1	174	0	164	9	134	10
HAMS: Irish (Smoked) "	1	286	9	232	6	192	5
American, Long Cut (Green) ... ... "	1	137	6	117	6	122	5
American, Short Cut "	1	132	0	113	0	129	7
	2	129	6	112	0	...	
Canadian, Long Cut "	1	...		...		130	0
EGGS: Country ... per doz.	1	3	3	3	7	4	6
	2	3	1	3	5	4	4
Irish ... ... per 120	1	25	11	33	11	44	0
	2	24	8	32	6	41	7
" (Cold Stored) "	1	...		29	0	30	3
" (Duck) ... "	1	...		34	0	40	0
American ... ... "	1	22	6	25	8	27	2
Canadian ... ... "	1	23	11	27	0	29	10
Argentine ... ... "	1	...		27	6	29	10
Danish (Fresh) ... "	1	25	9	33	10	41	7
	2	24	8	32	4	40	2
" (Pickled) ... "	1	...		26	6	26	6
Roumanian ... "	1	...		22	9	27	5
Moroccan ... ... "	1	...		...		23	0
Polish ... ... "	1	18	0	22	0	26	0
Lithuanian ... "	1	19	9	22	3	26	0
South African ... "	1	...		...		31	9

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

MARKETS.	Quality.	Second Earlies.	Late Varieties.			
			Red Soils.		Other Soils.	
			Lang-worthy.	Other.	Lang-worthy.	Other.
		SEPTEMBER.				
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Dundee	First ...	...	...	...	...	...
	Second ...	...	...	...	...	...
Edinburgh	First ...	7 7 6	...	...	...	...
	Second ...	...	...	...	...	...
Glasgow	First ...	6 13 0	...	...	...	...
	Second ...	...	...	...	...	...
		OCTOBER.				
Dundee	First ...	4 17 0	...	...	...	...
	Second ...	...	...	...	...	...
Edinburgh	First ...	5 2 6	...	...	...	...
	Second ...	...	...	...	...	...
Glasgow	First ...	6 13 0	...	...	...	6 0 0
	Second ...	...	...	...	...	...
		NOVEMBER.				
Dundee	First ...	4 11 0	...	...	...	5 17 6
	Second ...	...	...	...	...	...
Edinburgh	First ...	4 19 7	...	...	...	5 1 0
	Second ...	...	...	...	...	...
Glasgow	First ...	...	...	...	...	5 12 2
	Second ...	...	...	...	...	...

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters*).

Markets.	Quality.	Roots.			Hay.		Straw.			Moss Litter.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Barley.	Oats.	
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.
		SEPTEMBER.								
Dundee ...	1	...	25 6	...	136 11*	...	80 0*	60 0*	...	...
Edinburgh	1	...	...	...	125 0†	...	53 9†	40 8†	52 3†	...
Glasgow ...	1	...	...	...	...	...	...	...	...	42 6
		OCTOBER.								
Dundee ...	1	...	23 9	...	140 0*	...	82 6*	...	82 6*	...
Edinburgh	1	...	...	...	125 0†	...	51 3†	40 0†	50 0†	...
	2	...	...	...	90 0†	...	...	...	...	...
Glasgow ...	1	...	...	30 0	...	...	...	...	...	42 6
		NOVEMBER.								
Dundee ...	1	...	24 3	...	140 0*	...	80 2*	75 0*	87 0*	...
Edinburgh	1	...	...	...	125 0†	...	51 6†	42 6†	51 6†	...
	2	...	...	...	84 0†	...	...	...	...	...
Glasgow ...	1	...	...	32 6	...	...	...	...	...	42 6

* Price for Hay and Straw baled and delivered.

† Price for Hay and Straw delivered loose in town.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters)

Description.	September.		October.		November.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
*Home	16 0 0	16 3 9	13 13 9	13 7 6	14 2 6	13 13 6
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)	11 5 0	10 5 0	...	9 5 0	...	9 0 6
Egyptian (Home-manufactured)	11 6 8	...	9 17 6	...	10 1 0	...
*Palmnut Kernel Cake	...	...	...	10 2 6	...	8 14 0
Bean Meal ...	14 15 0	15 17 6	12 15 0	14 6 8	12 10 0	...
Maize	‡9 4 11	10 5 0	‡7 18 9	8 5 0	‡7 17 6	8 1 0
Maize Meal ...	10 8 9	11 5 0	9 6 3	9 5 0	9 10 0	9 1 0
Maize Gluten Feed (Paisley)	9 15 0	...	8 13 9	...	8 6 0	...
Maize Germ Meal	...	11 10 0	...	11 10 0	...	11 10 0
Maize Germ Cake Meal	...	...	...	...	12 0 0	...
Rice Meal... ...	9 17 6	...	9 12 6	...	8 7 6	...
Locust Bean Meal	...	10 10 0	...	9 15 0	...	8 14 0
Germ Cake (Paisley)	13 6 8	...	12 1 8	...	11 10 0	...
Barley (Feeding) ...	12 0 0	10 0 0	10 12 6	10 0 0	9 14 0	9 4 0
Oats	§11 9 6	11 2 6	§10 4 5	9 2 6	§10 7 6	8 18 0
*Malt Culms	6 17 6	6 0 0	5 5 0	5 5 0	5 6 0	5 4 0
Distillery Mixed Grains—						
Dried	9 1 3	8 5 0	8 0 0	7 18 9	8 5 0	8 4 0
Wet	...	1 14 3	...	1 15 0	...	1 15 0
Brewers' Grains—						
Dried	8 2 6	7 15 0	7 7 6	7 8 9	7 14 0	7 10 0
Wet	...	1 14 3	...	1 15 0	...	1 15 0
Wheat—						
†Middlings (Fine Thirds or Parings)	12 17 6	12 5 0	11 7 6	10 7 6	10 10 0	9 19 0
Sharps (Common Thirds)	10 3 9	...	9 1 3	...	8 17 0	...
†Bran (Medium) ...	9 3 9	8 18 9	8 2 6	7 13 9	8 16 0	8 15 0
Feeding Treacle ...	9 0 0	9 0 0	9 2 6	9 0 0	7 12 6	8 5 0
Crushed Linseed ...	...	...	...	28 13 4	...	28 0 0
Fish Meal... ...	15 10 0	16 0 0	15 10 0	15 10 0	15 7 0	15 10 0

* Price of bags and authorised transport charges are not included.
† Price of sacks included. ‡ American corn. § Canadian.

ACREAGE UNDER EACH VARIETY, AS RETURNED BY GROWERS OF ONE ACRE AND OVER, OF POTATOES IN SCOTLAND (1921).

VARIETY.	Acres.
A. FIRST EARLIES.	
1. America	57
2. Arran Rose	169
3. Dargill Early	241
4. Edzell Blue	376
5. Resistant Snowdrop ...	18
6. Witch Hill	172
7. Beauty of Hebron ...	98
8. Duke of York (including Midlothian Early) ...	1,246
9. Early Puritan	88
10. Early Rose	16
11. Eclipse (including Sir John Llewellyn) ...	1,761
12. Epicure...	9,504
13. May Queen	161
14. Myatt's Ashleaf Kidney	111
15. Ninetyfold	85
16. Sharp's Express	887
17. Sharp's Victor	109
18. Snowdrop	18
19. Other First Earlies not specified above	403
Total First Earlies ...	15,520
B. SECOND EARLIES.	
20. Arran Comrade	5,607
21. Great Scott (including Sir Douglas Haig, Southampton Wonder, and Conqueror)	13,196
22. Kate Glover *	14
23. King George V.	2,327
24. The Ally	1,379
25. The Duchess	14
26. British Queen (including Pioneer)	5,592
27. Queen Mary...	207
28. Royal Kidney	82
29. Windsor Castle	35
30. Other Second Earlies not specified above	2,006
Total Second Earlies	30,459

VARIETY.	Acres.
C. MAINCROPS.	
31. Abundance (including Culdees Castle, The Provost, The Crofter, The Admiral, and Favourite)	2,603
32. Arran Victory	1,185
33. Bishop	257
34. Burnhouse Beauty ...	34
35. Crusader *	130
36. Dominion	36
37. Golden Wonder	5,305
38. Irish Queen	108
39. Kerr's Pink	11,809
40. K. of K.*	214
41. Langworthy (including What's Wanted) ..,	2,279
42. Lochar (including Heather Bountiful)	1,680
43. Majestic	2,142
44. Nithsdale *	71
45. Rector	6
46. Rhoderick Dhu *... ...	78
47. Templar	434
48. Tinwald Perfection (including Rob Roy) ...	4,179
49. Arran Chief	28,288
50. Champion	2,686
51. Evergood	1,386
52. King Edward VII. ...	14,038
53. Northern Star	372
54. President (including Iron Duke and Scottish Farmer)	1,327
55. Twentieth Century ...	71
56. Up-to-Date (including Dalhousie Factor, Table Talk, Scottish Triumph, Dalmeny Beauty, Dalmeny Regent, Duchess of Cornwall, and Mayfield Blossom)	4,665
57. White City	68
58. Other Maincrops not specified above	4,212
Total Maincrops ...	89,663

TOTAL AREA RETURNED ... 135,642

NOTES.—(1) The varieties marked * were not returned separately in 1920.

The following Varieties were returned separately in 1920, but are this year included as "not specified":—

"Dunnottar Castle" (First Early), "Conquest" (Second Early), "Leinster Wonder," "St. Malo Kidney," and "Summit" (Maincrops).

(2) In the county of Inverness the districts of Skye, Harris, North and South Uist were excluded. In the county of Ross, the Western and South-Western districts and the district of Lewis were excluded.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1921.

Collected 4th June, 1921 (and comparison with 1920).

CROPS.

Distribution.	1921.	1920.	INCREASE.		DECREASE.	
	Acres.	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
TOTAL AREA (excluding WATER)	**19,069,683**	19,069,683	..	..	..	..
TOTAL ACREAGE under all CROPS and GRASS (*a*)	**4,729,604**	4,739,046	..	..	9,442	0·20
ARABLE LAND	**3,349,067**	3,380,237	..	..	31,170	0·92
PERMANENT GRASS (*a*) For Hay	**142.964**	152,164	..	..	9,200	6·05
Not for Hay ..	**1.237.573**	1,206,645	30,928	2·56	..	.
Total.. ..	**1,380,537**	1,358,809	21,728	1·60	..	..
Wheat	**65,191**	54,359	10.832	19·93	..	..
Barley (including Bere)	**170,721**	204,369	..	..	33,648	16·46
Oats	**1.011,615**	1,032,198	..	..	20,583	1·99
Mixed Grain	**704**	2,268	..	..	1,564	68·96
Rye..	**6,201**	6,810	..	..	609	8·94
Beans (to be harvested as Corn)	**4,704**	5,726	..	..	1.022	17·85
Peas	**399**	371	28	7·55	..	..
Potatoes	**153,820**	162,477	..	..	8,657	5·33
Turnips and Swedes	**410,789**	425,255	..	..	14,466	3·40
Mangolds	**1.771**	1,768	3	0·17	..	..
Cabbage	**3,587**	3,498	89	2·54	..	..
Rape	**16.717**	14,879	1,838	12·35	..	..
Vetches or Tares, for Seed	**301**	358	..	..	57	15·92
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	**10,066**	11,146	..	..	1,080	9·69
Carrots	**298**	315	..	..	17	5·40
Onions	**137**	168	.	.	31	18·45
Flax	**452**	1,638	.	..	1,186	72·41
Small Fruit	**6.304**	6,270	34	0·54	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER For HAY	**410,556**	425,256	..	..	14,700	3·46
Not for HAY ..	**1,066,066**	1,012,574	53,492	5·28	..	..
TOTAL	**1,476,622**	1,437,830	38,792	2·70	..	..
OTHER CROPS	**1,758**	1,863	..	..	105	5·64
BARE FALLOW	**6.910**	6,671	239	3·58	..	..
ORCHARDS (*b*)	**1,583**	1,617	..	..	34	2·10

LIVE STOCK.

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding) .. .	**139.217**	138,251	966	0·70	..	..
Unbroken Horses (including Stallions). One year and above	**40,119**	37,533	2,586	6·89	..	..
Under one year ..	**12,677**	14,792	..	..	2,115	14·30
TOTAL	**192,013**	190,576	1,437	0·75	..	..
Other Horses	**24.608**	23,761	847	3·56	..	..
TOTAL OF HORSES	**216,621**	214,337	2,284	1·07	..	..
Cows in Milk	**346,495**	350,115	..	..	3,620	1·03
Cows in Calf, but not in Milk	**41,724**	38,137	3,587	9·41	..	..
Heifers in Calf	**54,829**	46,227	8,602	18·61	..	..
Bulls being used for Service	**18.463**	17,724	739	4·17	..	..
Other Cattle :—Two years and above ..	**228,173**	228,149	24	0 01	..	..
,, ,, One year and under two ..	**232,262**	269,187	..	..	36,925	13·72
,, ,, Under one year	**221.189**	216,173	5,016	2·32	..	..
TOTAL OF CATTLE	**1.143,135**	1,165,712	..	..	22,577	1·94
Ewes kept for Breeding	**2,814.812**	2,756,424	58,388	2·12	..	..
Rams to be used for Service in 1921	**80,070**	77,362	2,708	3·50	..	..
Other Sheep :—One year and above.. ..	**1,029.714**	1,013,512	16,202	1·60	..	..
,, ,, Under one year	**2,733,915**	2,513,630	220,285	8·76	..	..
TOTAL OF SHEEP	**6,658,511**	6,360,928	297,583	4·68	..	..
Sows kept for Breeding	**17,962**	14,580	3,382	23·20	..	..
Boars being used for Service	**1,927**	1,605	322	20·06	..	..
Other Pigs	**125,609**	112,374	13,235	11·78	..	..
TOTAL OF PIGS	**145.498**	128,559	16,939	13·18	..	..

(*a*) Excluding Mountain and Heath Land used for grazing (9,580,302 acres in 1921).
(*b*) Any Crop or Grass grown in Orchards is also returned under its proper heading.

ACREAGE under WHEAT, BARLEY (including Bere), and OATS in each COUNTY on 4th June 1921, with COMPARISON for 1920.

COUNTIES.	**Wheat.**		**Barley (including Bere).**		**Oats.**	
	1921.	1920.	1921.	1920.	1921.	1920.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN . .	38	33	23,392	29,772	191,763	190,938
ARGYLL . . .	...	...	1,292	1,751	17,177	18,114
AYR . . .	1,418	1,104	452	549	45,639	47,490
BANFF . . .	1	...	8,494	9,505	48,651	48,636
BERWICK . .	3,627	3,031	17,715	20,543	31,516	32,073
BUTE . . .	4	27	7	51	5,172	5,194
CAITHNESS . .	...	...	749	1,196	31,275	31,894
CLACKMANNAN .	428	445	236	266	3,328	3,507
DUMBARTON . .	839	838	35	31	7,999	8,621
DUMFRIES . .	124	116	437	742	42,769	44,663
FIFE . . .	13,461	10,894	15,089	18,031	46,921	47,629
FORFAR . . .	10,480	8,995	19,189	22,904	57,747	57,241
HADDINGTON .	6,365	4,050	14,743	17,702	17,891	18,073
INVERNESS . .	89	111	5,775	6,096	30,084	29,652
KINCARDINE . .	1,105	1,070	10,485	13,091	31,622	30,521
KINROSS . .	297	172	237	411	7,882	8,159
KIRKCUDBRIGHT .	3	21	35	188	26,340	28,900
LANARK . .	2,902	2,696	140	296	42,254	46,098
LINLITHGOW . .	2,656	2,219	2,160	3,001	11,800	12,114
MIDLOTHIAN . .	6,227	4,539	5,519	7,629	22,152	22,468
MORAY . . .	811	580	10,167	10,784	24,591	24,629
NAIRN . . .	13	25	2,458	2,465	6,380	6,354
ORKNEY . .	...	...	3,739	4,154	34,469	34,603
PEEBLES . .	6	...	336	625	7,056	7,520
PERTH . . .	8,182	7,782	4,926	6,480	76,586	77,996
RENFREW . .	2,155	2,073	21	80	11,536	12,331
ROSS & CROMARTY	999	779	8,944	9,681	32,628	32,769
ROXBURGH . .	583	577	10,595	12,354	27,728	28,683
SELKIRK . .	26	18	372	479	4,141	4,607
SHETLAND . .	...	...	806	857	6,567	6,854
STIRLING . .	2,181	2,029	1,358	1,664	20,211	21,240
SUTHERLAND . .	...	...	506	623	7,722	7,850
WIGTOWN . .	171	135	312	368	32,018	34,777
TOTAL .	65,191	54,359	170,721	204,369	1,011,615	1,032,198

ACREAGE under BEANS, POTATOES, and TURNIPS and SWEDES in each COUNTY on 4th June 1921, with COMPARISON for 1920.

COUNTIES.	**Beans.***		**Potatoes.**		**Turnips and Swedes.**	
	1921.	1920.	1921.	1920.	1921.	1920.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN .	8	...	7,635	7,723	82,633	83,959
ARGYLL . .	30	45	3,443	3,591	5,390	5,645
AYR . .	270	473	9,853	10,504	7,529	7,828
BANFF . .	34	57	1,903	1,925	20,202	20,475
BERWICK. .	458	679	2,714	2,740	22,347	23,330
BUTE . .	23	42	1,159	1,293	1,300	1,286
CAITHNESS .	...	...	1,417	1,413	11,385	11,903
CLACKMANNAN	256	246	467	553	758	770
DUMBARTON .	28	6	2,741	2,989	1,398	1,415
DUMFRIES .	13	40	4,534	4,962	15,399	16,211
FIFE . .	446	292	17,679	18,361	21,260	22,268
FORFAR . .	64	49	18,479	18,725	30,816	31,809
HADDINGTON .	137	142	7,774	7,959	12,906	13,502
INVERNESS .	3	2	5,464	5,513	9,364	9,626
KINCARDINE .	27	49	4,528	4,588	15,610	16,213
KINROSS . .	1	...	1,328	1,527	2,452	2,542
KIRKCUDBRIGHT	7	30	1,795	1,956	10,213	11,160
LANARK . .	62	117	6,426	7,135	9,434	9,810
LINLITHGOW .	11	50	2,601	2,811	3,185	3,264
MIDLOTHIAN .	24	16	6,975	7,456	9,462	9,742
MORAY . .	13	20	1,697	1,855	13,841	14,120
NAIRN . .	...	...	277	288	3,780	3,895
ORKNEY . .	...	...	2,396	2,436	13,733	13,862
PEEBLES . .	...	...	461	580	3,209	3,408
PERTH . .	824	1,097	19,605	21,445	25,071	26,050
RENFREW .	92	131	3,283	3,549	2,130	2,231
ROSS AND CROMARTY .	1	2	6,800	7,364	14,323	14,916
ROXBURGH .	137	180	1,280	1,434	18,564	19,602
SELKIRK . .	...	...	181	217	2,275	2,458
SHETLAND .	...	...	2,279	2,330	1,029	1,063
STIRLING. .	1,634	1,774	3,589	4,193	3,862	3,968
SUTHERLAND .	...	..	1,283	1,372	2,797	2,767
WIGTOWN .	101	187	1,774	1,690	13,132	14,157
TOTAL .	4,704	5,726	153,820	162,477	410,789	425,255

* To be harvested as corn.

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1921, with COMPARISON for 1920.

COUNTIES.	**Rye-grass and other Rotation Grasses and Clover.**				**Permanent Grass.**			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1921.	1920.	1921.	1920.	1921.	1920.	1921.	1920.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN .	50,767	50,228	235,247	227,786	841	1,289	31,625	32,541
ARGYLL . .	12,266	12,403	16,094	16,260	14,471	14,254	57,458	54,849
AYR . .	26,537	32,926	51,374	46,006	20,722	21,223	147,270	142,016
BANFF . .	10,474	9,821	57,977	57,491	314	377	9,806	9,820
BERWICK .	11,166	11,275	48,187	45,525	1,686	1,892	48,677	46,789
BUTE . .	2,396	2,529	6,060	4,853	399	690	8,626	9,270
CAITHNESS .	10,279	10,156	25,787	25,531	805	742	25,178	23,927
CLACKMANNAN	1,519	1,375	1,615	1,474	1,029	1,323	5,526	5.311
DUMBARTON .	5,526	6,145	5,665	5,287	1,910	2,011	20,536	19,562
DUMFRIES .	19,266	21,351	49,041	44,972	17,482	17,896	95,250	94,233
FIFE . .	27,073	27,425	29,141	26,830	2,673	2,767	66,069	65,754
FORFAR . .	23,095	22,502	60,098	58,172	1,168	1,604	22,499	22,285
HADDINGTON .	9,770	10,631	16,529	14,307	447	1,057	20,929	20,048
INVERNESS .	11,722	11,797	19,887	19,981	7,899	8,353	56,214	55,317
KINCARDINE .	13,701	13,155	32,984	31,295	167	220	7,577	8,173
KINROSS . .	3,180	3,098	6,333	6,268	677	689	10,674	10,319
KIRKCUDBRIGHT	10,661	10,999	46,002	39,569	11,262	11,844	71,633	73,142
LANARK . .	31,773	34,499	35,353	34,395	12,501	13,554	101,634	95,065
LINLITHGOW .	7,154	7,613	5,557	4,479	1,016	1,279	20,401	19,683
MIDLOTHIAN .	11,500	12,504	15,747	14,065	1,755	2,509	39,451	38,191
MORAY . .	5,935	5,628	33,016	33,116	146	243	7,517	6,775
NAIRN . .	1,983	1,487	8,764	8,816	22	80	1,908	1,956
ORKNEY . .	10,449	9,464	28,480	29,062	359	374	14,026	137,90
PEEBLES . .	2,482	2,821	11.892	10,932	1,454	1,342	22,687	22,450
PERTH . .	33,595	34,606	59,737	55,459	10,590	11,340	80,290	79,904
RENFREW .	9,099	9,973	6,859	6,375	6,016	7,307	42,547	39,853
ROSS AND CROMARTY .	14,015	14,147	32,082	30,713	2,562	2,152	23,232	23,032
ROXBURGH .	8,924	9,659	45,138	41,687	6,470	6,906	55,856	54,148
SELKIRK .	1,165	1,600	6,954	5,927	1,734	1,858	12,708	12,393
SHETLAND .	1,416	1,414	585	626	1,691	1,670	10,498	10,917
STIRLING .	11,398	11,983	10,274	9,378	6,804	7,370	49,697	47,754
SUTHERLAND .	4,485	4,700	5,165	5,316	1.486	1,543	6,529	5,935
WIGTOWN .	5,785	5,342	52,442	50,621	4,406	4,406	43,045	41,443
TOTAL .	410,556	425,256	1,066,066	1,012,574	142,964	152,164	1,237,573	1,206,645

NUMBER of HORSES, CATTLE, SHEEP, and PIGS in each COUNTY on 4th June 1921, with COMPARISON for 1920.

COUNTIES.	Horses.†		Cattle.		Sheep.		Pigs.	
	1921.	1920.	1921.	1920.	1921.	1920.	1921.	1920.
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
ABERDEEN .	30,594	31,032	167,420	170,116	191,986	170,437	14,873	10,362
ARGYLL . .	6,371	6,180	56,578	58,162	780,551	776,818	4,505	4,447
AYR . .	10,227	10,160	111,295	111,112	349,634	334,242	11,422	11,627
BANFF . .	8,806	8,669	43,669	43,740	57,667	55,747	3,747	2,541
BERWICK .	4,674	4,744	15,167	17 689	318,192	297,109	4,320	3,719
BUTE . .	1,354	1,327	9,590	9,685	39,476	38,498	735	627
CAITHNESS .	5,685	5,714	19,525	19,990	134,611	123,111	1,869	1,766
CLACKMANNAN	754	749	3,139	3,369	14,732	13,397	547	535
DUMBARTON .	1,859	1,855	13,405	13,316	66,230	64,512	1,208	1,115
DUMFRIES .	7,567	7,409	64,907	66,199	540,116	515,424	9,731	8,390
FIFE . .	9,846	9,501	40,457	40,984	90,330	82,214	7,471	6,090
FORFAR . .	9,171	8,803	44,250	44,238	156,949	148,041	7,425	6,238
HADDINGTON .	3,515	3,470	10,404	8,781	124,194	110,941	2,410	1,970
INVERNESS .	8,308	8,137	44,766	47,108	500,268	496,950	1,873	1,578
KINCARDINE .	5,019	4,964	24,803	24,313	39,092	35,239	2,636	1,751
KINROSS . .	1,289	1,197	5,394	6,403	27,162	26,294	763	687
KIRKCUDBRIGHT	5.239	5,125	53,600	54,930	362,305	337,645	11,048	10,908
LANARK . .	8,410	8,453	70,116	70,684	225,745	220,560	7,687	7,424
LINLITHGOW .	2,226	2,272	10,795	11,290	14,302	12,086	1,523	1,472
MIDLOTHIAN .	3,891	3,873	15,687	16,374	170,100	160,036	10,216	9,495
MORAY . .	5,027	4,956	22,074	21,903	43,872	40,215	2,292	1,561
NAIRN . .	1,346	1,308	5,907	6,110	13,517	13,393	851	566
ORKNEY . .	6,608	6,512	30,270	31,598	31,907	29,786	1,883	1,306
PEEBLES . .	1,104	1,102	6,509	6,786	201,141	192,185	487	363
PERTH . .	13,050	12,902	61,351	66,134	572 534	552.309	8,979	7,136
RENFREW .	3,062	3,121	25,797	25,911	37,517	33,532	2,904	2,018
ROSS AND CROMARTY .	6,892	7,023	38,265	39,324	269 369	258,893	3,197	2.569
ROXBURGH .	3,903	4,013	17,863	19,112	518,722	493,277	3,316	2,877
SELKIRK . .	613	599	3,089	3,025	182,187	173,245	665	427
SHETLAND .	2,876	2,845	13,511	13,498	152,360	140,150	569	398
STIRLING .	4,818	4,756	30,086	29,937	114,386	107,938	2,559	2,239
SUTHERLAND .	2,168	2,123	9,741	10,198	205,566	199,204	587	451
WIGTOWN .	5,741	5,682	53,705	53,693	111,791	107,500	11,200	13,906
TOTAL .	192,013	190,576	1,143,135	1,165,712	6,658,511	6,360,928	145,498	128,559

† Horses used for agricultural purposes, mares for breeding, and unbroken horses (including stallions). "Other horses" on agricultural holdings are not included; the total of these for Scotland is given in the summary table on p. 109.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1921.

COUNTY AND DISTRICT OF COUNTY.		Wheat	Barley (including Bere.)	Oats.	* Beans.	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		† Horses	Cattle.	Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*No.*	*No.*	*No.*	*No.*
ABERDEEN	Aberdeen	4	6,205	17,714	..	1,769	9,810	7,566	25,590	19	2,398	3,644	18,943	7.640	3,487
	Alford	..	880	17,272	.	344	7,839	4,856	21,735	216	5,170	2,811	15,645	35,648	662
	Deer	..	2,677	44,368	6	2,108	17,020	12,152	46,000	196	8,301	6,651	37,348	27,373	3,361
	Deeside	..	2,312	14,861	..	470	6,981	5,787	19,389	..	4,168	2,662	14,504	43,937	906
	Ellon	34	3,577	28,338	1	955	12,570	7,387	35,147	131	3,378	3,675	24,172	20,216	1,673
	Garioch	..	3,687	24,354	..	740	10,906	5,679	31,179	203	2,748	4,069	21,275	13,713	1,404
	Huntly	..	1,150	16,076	..	382	6,477	2,550	22,916	12	3,653	2,801	13,005	32,584	1,234
	Turriff	..	2,904	28,780	1	867	11,030	4,790	33,291	64	1,809	1,281	22,528	10,875	2,146
ARGYLL	Ardnamurchan	..	..	416	..	269	51	625	183	1,266	1,622	156	2,970	66,264	62
	Cowal	..	5	1,386	..	295	436	1,072	1,375	1,760	5,512	436	4,516	148,953	174
	Islay	..	17	4,147	..	596	1,245	2,932	2,458	1,501	18,631	1,314	10 366	75,587	672
	Kintyre	..	561	4,828	30	486	2,201	1,472	9,499	1,217	11,449	1,094	13,838	125,453	2,275
	Lorn	..	2	2,450	..	737	641	2,730	697	3,914	5,717	935	9,152	175,495	496
	Mid-Argyll	..	..	1,717	..	406	518	1,825	1.343	2,471	7,798	632	7,553	113,410	379
	Mull	..	707	2,233	..	660	298	1,610	539	2,342	6,729	1,204	8,183	75,389	447
AYR	Ayr	239	13	12,061	139	1,866	1,787	6,990	13,898	6,545	40,065	2,506	29,709	105,279	3,908
	Carrick	148	386	10,779	84	4,155	2,963	4,838	12.391	3,728	34,281	2,466	23,337	179,186	2,444
	Kilmarnock	581	2	11,618	32	1,180	1,340	8,098	14,322	5,464	37,707	2,695	32,007	27,551	3,884
	Northern	450	51	11,243	15	2,652	1,439	6,611	10,763	4,985	35,217	2,560	26,242	37,618	1,186
BANFF	Banff	1	6,841	26,973	34	1,314	11,985	5,942	33,413	177	2,226	5,015	26,095	15,037	2,695
	Keith	..	1,653	21.678	..	589	8,217	4,532	24,564	137	7,580	3,791	17,574	42,630	1,052
BERWICK	East	1,531	6,865	9 391	185	1,300	7,014	3,791	14,814	241	13,946	1,549	4,288	77,625	1,822
	Middle	1,836	8,067	10,698	237	875	8,582	4,920	13,166	606	18,476	1,823	6,135	112,610	1,521
	West	260	2,783	11,427	36	539	6,751	2,475	20,207	839	16,255	1,302	4,744	127,957	977
BUTE	Arran	3	7	2,457	23	679	418	1,179	2,433	318	4,263	685	4,612	31.221	385
	Bute and Cumbrae	1	..	2,715	..	480	882	1,217	3,627	81	4,363	669	4,978	8,255	350
CAITHNESS (Not divided)		..	749	31,275	..	1,417	11,385	10,279	25,787	805	25,178	5,685	19,525	134,611	1,869
CLACKMANNAN (Not divided)		428	236	3,328	256	467	758	1,519	1,615	1,029	5,526	754	3,139	14,732	547
DUMBARTON	Eastern	657	26	4,135	14	1,310	647	3,163	2,442	855	9,176	986	6,108	10,284	745
	Western	182	9	3,864	14	1,431	751	2,363	3,223	1,055	11.360	873	7,297	55,946	463
DUMFRIES	Annan	29	202	13,791	10	1,617	4,663	5,432	13,209	2,407	16,676	2,214	14,182	43,073	2,521
	Dumfries	70	94	10,323	..	1,394	3,540	3,693	12,524	2,121	13,625	1,698	13,002	45,846	2,275
	Langholm	..	5	2,478	..	225	1,013	1,415	2,732	3,031	7,983	546	4,894	121,810	557
	Lockerbie	25	132	9,670	2	751	3,834	4,643	12,697	5,372	24,878	1,786	17,410	143,670	1,893
	Thornhill	..	4	6,507	1	547	2,349	4,083	7,879	4,551	32,138	1,323	15,419	185,717	2,485

* To be harvested as corn.

† See Note on p. 113.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1921.

COUNTY AND DISTRICT OF COUNTY.		Wheat	Barley (including Bere).	Oats.	Beans.*	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		Horses†	Cattle.	Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
FIFE	Cupar	4,283	4,927	15,217	36	6,091	7,531	7,467	12,352	386	14,883	2,887	10,777	35,518	2,105
	Dunfermline	1,534	823	8,411	150	1,986	2,621	4,732	3 596	841	20,558	1,844	8,643	20,812	1,237
	Kirkcaldy	2,817	2,697	10,607	20	3,889	4,164	6,616	5,955	751	13,196	2,249	9,097	16,853	2,279
	St. Andrews	4,827	6,642	12,686	240	5,713	6,944	8,258	7,238	695	17,432	2,866	11,940	17,147	1,850
FORFAR	Arbroath	2,600	4,950	10,489	6	4,245	6,514	4,801	10,317	61	2,757	1,830	8,367	5,200	1,191
	Brechin	2,525	6,263	18,092	58	4,367	9,440	7,050	19,401	357	6,646	2,689	13,270	59,751	1,686
	Dundee	3 067	3,014	10,519	..	4,720	5,894	4,975	9,602	238	3,095	1,806	8,898	12,341	2,459
	Forfar	2,288	4,962	18.647	..	5,147	8,968	6,269	20,778	512	10,001	2,846	13,715	79,657	2,089
HADDINGTON	Eastern	1,952	5,975	5,587	47	3,109	4,786	3,053	6,831	238	8.305	1,296	3,721	62,408	746
	Western	4,413	8,768	12,304	90	4,665	8,120	6,717	9,698	209	12,624	2,219	6,683	61,786	1,664
INVERNESS	Inverness	21	2,243	7,529	2	470	4,359	3,060	9,645	219	4,845	1,568	6.475	40,734	731
	Aird	68	173	6,329	1	551	2,603	2,936	5,304	280	4,552	1,161	5,714	37,411	773
	Badenoch	..	120	4,411	..	202	1,679	2,348	3,851	1,164	8,981	850	4,737	90,697	186
	Lochaber	..	7	1,260	..	517	311	1,537	411	2,111	2,565	410	4,870	140,041	146
	Skye	..	4	5,541	..	1,308	308	1,575	546	2,618	4,241	1,065	9,355	131,014	11
	Harris, N. & S. Uist	..	3,228	5,014	..	2,416	104	266	130	1,507	31,030	3,254	13,615	60,371	26
KINCARDINE	Laurencekirk	361	2,204	10,118	3	1,616	4,324	3,684	8,407	54	1,750	1.250	6,127	13,302	682
	Lower Deeside	..	1,342	3,466	..	721	1,835	2,103	3,455	..	362	673	3,036	216	520
	St. Cyrus	644	2,412	5,991	10	1,139	2,938	2,539	5,530	36	2,055	906	3,806	8,092	366
	Stonehaven	100	2,983	8,169	14	773	4,307	3,772	9,910	77	2,183	1,399	7,795	10,715	669
	Upper Deeside	..	1,544	3,878	..	279	2,206	1,603	5,682	..	1,227	791	4,039	6,767	399
KINROSS (Not divided)		297	237	7,882	1	1,328	2,452	3,180	6,333	677	10,674	1,289	5,394	27,162	763
KIRKCUDBRIGHT	Eastern	..	20	11,225	4	1,191	4,032	4,422	14,832	2,986	24,244	2,013	18,055	62,821	3,158
	Northern	..	2	1,961	..	133	807	853	3,388	2,541	9,436	558	5,616	145,515	883
	Southern	2	13	10,811	..	372	4,506	4,408	24,781	4,260	27,678	2,193	24,468	70,989	6,448
	Western	1	..	2,343	3	99	868	978	3,001	1,475	10,275	475	5,461	82,980	559
LANARK	Lower Ward	1,126	27	4,537	16	1,512	565	3,283	1,897	2,359	6,408	935	4,514	905	2,436
	Middle Ward	1,680	82	18,714	45	2,475	3 270	17,252	12,999	5,757	49,886	4,034	35,855	27,368	3,321
	Upper Ward	96	31	18,973	1	2,439	3,599	11,238	20,457	4,385	45,340	3,441	29,747	197,472	1,930
LINLITHGOW	Bathgate	376	392	5,488	2	653	1,143	3,311	2,902	608	13,285	1,078	6,648	6,158	504
	Linlithgow	2,280	1,768	6,312	9	1,948	2,042	3,843	2,655	408	7,116	1,148	4,147	8,144	1,019
MID-LOTHIAN	Calder	1,648	974	5,973	..	1,868	1,591	3,563	2,154	602	13,591	1,192	5,154	33,949	1,552
	Gala-Water	332	1,594	5,985	6	370	3,780	1,481	10,546	361	14,391	776	2,733	94,562	367
	Lasswade	1,564	1,850	6,096	15	1,980	2,718	3,552	2,753	633	8,124	1,116	3,938	34,026	991
	Suburban	2,683	1,101	4,098	3	2,757	1,373	2,904	294	159	3,345	807	3,862	7,563	7,306
MORAY (Not divided)		811	10,167	24,591	13	1,697	13,841	5,985	33,016	146	7,517	5,027	22,074	43,872	2,292

* To be harvested as corn.

† See Note on p. 113.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1921.

COUNTY AND DISTRICT OF COUNTY.		Wheat	Barley (including Bere.)	Oats.	* Beans.	Potatoes.	Turnips and Swedes	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		† Horses	Cattle.	Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*No.*	*No.*	*No.*	*No.*
NAIRN (Not divided)		13	2,458	6,380	..	277	3,780	1,983	8,764	22	1,908	1,346	5,907	13,517	851
ORKNEY	Mainland	..	1,137	19,283	..	1,262	7,062	6,101	15,212	312	7,362	3,691	15,654	12,210	997
	North Isles	..	2,254	10,209	..	776	4,783	2,887	9,864	24	5,527	2,160	10,561	14,240	709
	S. Ronaldshay & Walls	..	348	4,977	..	358	1,888	1,461	3,404	23	1,137	757	4,055	5,457	177
PEEBLES (Not divided)		6	336	7,056	..	461	3,209	2,482	11,892	1,454	22,687	1,104	6,509	201,141	487
PERTH	Blairgowrie	2,147	2,149	16,886	..	5,335	6,498	6,661	14,907	576	11,726	2,534	11,323	53,861	1,874
	Central	815	233	16,834	7	4,089	4,758	7,136	13,705	1,586	15,644	2,766	11,741	116,007	1,913
	Highland	6	131	7,253	..	928	2,696	4,768	6,553	2,182	13,845	1,516	9,056	185,157	1,289
	Perth	4,841	2,174	24,275	334	7,072	8,898	10,011	17,212	1,759	21,723	3,807	16,602	47,139	2,979
	Western	373	239	11,338	483	2,181	2,221	5,019	7,369	4,487	17,352	2,427	12,629	170,370	924
RENFREW	First or Upper	1,305	19	5,209	5	1,411	975	4,271	2,459	3,636	21,871	1,426	12,757	16,928	1,250
	Second or Lower	850	2	6,327	87	1,872	1,155	4,828	4,400	2,380	20,676	1,636	13,040	20,589	1,654
ROSS & CROMARTY	Black Isle	14	2,786	7,327	..	742	4,123	3,342	8,926	41	1,235	1,557	5,472	10,950	734
	Easter Ross	862	1,818	10,527	..	1,321	5,497	4,605	12,595	282	5,042	1,978	8,133	62,102	1,382
	Mid Ross	123	1,740	9,473	1	758	4,337	4,238	9,981	609	5,370	1,814	8,610	69,707	1,011
	S.-W. and Western	..	22	1,869	..	698	217	1,554	496	1,481	2,073	379	4,524	73,187	55
	Lewis	..	2,578	3,432	..	3,281	149	176	84	149	9,512	1,164	11,526	53,423	15
ROXBURGH	Hawick & Liddesdale	21	141	3,674	..	199	1,988	1,333	5,626	3,569	12,698	618	4,966	178,471	636
	Jedburgh	73	2,272	8,383	15	304	5,190	2,375	15,107	1,442	16,870	1,190	5,285	148,535	841
	Kelso	374	6,637	9,308	102	560	7,589	3,348	14,897	798	12,939	1,293	4,886	129,776	1,125
	Melrose	115	1,545	6,363	20	217	3,797	1,868	9,508	661	13,349	802	2,726	61,940	714
SELKIRK (Not divided)		26	372	4,141	..	181	2,275	1,165	6,954	1,734	12,708	613	3,089	182,187	665
SHETLAND	Mainland	..	779	5,344	..	1,855	895	1,079	495	1,213	7,690	1,904	10,273	120,482	350
	North Isles	..	27	1,223	..	424	134	337	90	478	2,808	972	3,238	31,878	219
STIRLING	Central	958	682	8,210	902	1,458	1,657	4,155	4,434	3,720	16,225	2,112	11,632	36,613	1,035
	Eastern	1,060	662	6,668	672	955	1,179	4,071	2,288	1,526	15,853	1,409	8,688	4,297	955
	Western	163	14	5,333	60	1,176	1,026	3,172	3,552	1,558	17,619	1,297	9,766	73,476	569
SUTHERLAND (Not divided)		..	506	7,722	.	1,283	2,797	4,485	5,165	1,486	6,529	2,168	9,741	205,566	587
WIGTOWN	Machars	151	299	12,908	91	406	5,065	3,610	19,745	3,225	29,880	2,691	25,138	61,015	3,452
	Rhins	20	13	19,110	10	1,368	8,067	2,175	32,697	1,181	13,165	3,050	28,567	50,776	7,748

* To be harvested as corn.

† See Note on p. 113.

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SCIENCE AND CROP PRODUCTION.

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It would be easy to draw up a long account showing the help that has been given to the farmer by the great men of agricultural science in past years—by Lawes and Gilbert at Rothamsted, and by Augustus Voelcker, Johnston, Aitken and others, to mention only some of the British workers. The object of the present article, however, is not historical but to set forth some of the things that are being attempted at the present day to bring the methods and results of modern science to aid the farmer in the growth of his crops. When we see how greatly science has assisted the engineer in our own time; how it has enabled him to construct the motor and aëroplane and develop them to their present high pitch of perfection within the memory of all of us, we cannot for a moment believe that it is unable to help the farmer.

Fertilisers.—Probably the chief help given to crop production by science in the past fifty years has been in the development of artificial manures. To so great an extent has this branch of science grown that a farmer who has once ascertained the needs of his crop can be offered a considerable range of materials capable of supplying these needs, and possessing also other clearly defined properties, and can make his choice among them with reasonable certainty of securing something that will help the crop and benefit himself.

Potassic.—But there is no finality about science or industry. Although chemists have been studying artificial fertilisers for eighty years there are still important problems to be solved. One of great importance at the present time is the question whether chlorides (otherwise known as muriates) are as good fertilisers as sulphates. The most pressing case is that of potassic fertilisers. Prior to the war the whole of the potassic fertilisers of the world came from one source—Stassfurt in Germany—and it was immaterial whether farmers used the sulphate, the muriate or kainit. In practice they generally used the sulphate or kainit, and the expert advisers were usually able to say when the one or the other would be the better. But since the war a proportion of the potash mines have been transferred to France, so that we now receive potash from two sources—the old Stassfurt mines in

Germany and the Alsatian mines belonging to France. At the present these are independent of each other and are both competing for the farmers' custom. The Germans still offer sulphate, muriate and kainit; the French, however, offer only muriate and sylvenite, a kainit containing no magnesia. If the farmer knew for certain that the muriate was just as effective as the sulphate on his land he could bargain freely with the two sellers; but not knowing this he is in a less certain position. Ten years ago a thorough investigation of the whole problem could have been made at a small cost; at the present time the farmers of the United Kingdom are spending, probably not less than £400,000 per annum on these fertilisers, and for lack of this knowledge they cannot buy with the certainty they might otherwise have done.

Nitrogenous.—A parallel problem in connection with the nitrogen fertilisers is already coming within the range of practice. During the war chemists all over the civilised world were busy making high explosives, and it so happens that these are all nitrogen compounds. The supply of combined nitrogen proving inadequate, processes were developed for "fixing" the gaseous nitrogen of the atmosphere; prodigious quantities of ammonia and of nitrates were thus produced. They were consumed during the war as high explosives, but out of this great evil came some good, for they are now available as fertilisers. Twenty-five years ago the supply of nitrogen fertiliser was a source of great anxiety, and indeed in 1898 a distinguished man of science, Sir William Crookes, cautioned the world that it might have to face a serious food shortage in 1931 unless larger quantities of these fertilisers could be produced. This is now done, and all fear on this account has vanished; the world's supply of nitrogenous fertilisers available for the farmer, which in 1898 was 400,000 tons of sulphate of ammonia per annum and 1,200,000 tons nitrate of soda per annum (the whole equivalent to 1,360,000 tons sulphate of ammonia per annum), is now estimated at the equivalent of 8,500,000 tons sulphate of ammonia per annum, and is capable of indefinite expansion. We have doubtless many troubles before us, but nitrogen starvation is no longer one. Here is a great triumph of science, even more recent than the motor car, and quite as new as the aeroplane. But it raises this important question for the agricultural chemist: In what form would the farmer prefer his nitrogen? The factories can turn it out in at least eight different forms: (1) Nitrate of Lime; (2) Nitrate of Ammonia; (3) Sulphate of Ammonia; (4) Muriate of Ammonia; (5) Carbonate of Ammonia; (6) Urea; (7) An organic form—Guanidine; (8) Cyanamide. Which of these are the most suitable?

Fortunately, considerable information about some of the fertilisers already exists. Nitrate of soda and sulphate of ammonia have been compared so often that the expert can advise with comparative certainty; before and during the war comparisons of nitrate of lime, nitrate of ammonia and cyanamide were made with one or other of these two fertilisers by Professor

Hendrick and others, and their properties are now pretty well known. But there remain muriate of ammonia, carbonate of ammonia, urea and guanidine, about which little is known in this country. If the manufacturer had only himself to consider he would probably prefer to make muriate of ammonia or urea; he could turn out the muriate more easily and more cheaply than sulphate of ammonia. But how would these substances, particularly the muriate of ammonia, suit the farmer? This question cannot yet be answered. Until last year the matter had been of scientific interest only, and had received practically no attention in this country.

Last year a certain number of tests were made with muriate of ammonia as compared with sulphate of ammonia, and they gave very interesting results. Some of them are set out in Table I. as illustrations of the difficulties attending a problem apparently so simple. The tests were all made with great care and skill, yet three different results were obtained: in some cases the muriate was better than the sulphate, in others equal, and in others again (these the majority) it was inferior to the extent of about 10 per cent. when the comparison is made on the basis of equal nitrogen content. We conclude that *in some conditions the muriate is as effective as the sulphate, in others it is not.* It is important to find out exactly what these conditions are so that the farmer can be advised quite definitely as to what results he may reasonably expect.

Phosphatic.—Another important set of fertiliser problems has come into prominence since the war. Every farmer knows about basic slag, but how many realise that three distinct substances are, quite properly, sold under this name. These are:

1. The Bessemer slag, the only one in ordinary use before the war, and certainly the one used in the classical trials at Cockle Park and elsewhere, which did so much to bring this fertiliser to the notice of farmers. It is now obtainable only from a few works.
2. Basic open-hearth slag of high solubility—a product which began to come in before the war and has now largely displaced the Bessemer slag.
3. Basic open-hearth slag of low solubility, which differs from the preceding in that it is made by the use of fluor spar.

Thanks to the work of Profs. D. A. Gilchrist and G. Scott Robertson, agricultural chemists have taken up the question of basic slag; the Agricultural Education Association has organised an extensive series of trials, and the Ministry of Agriculture has appointed a permanent committee to study the matter fully. Broadly speaking, the results up to the present indicate that the highly soluble open-hearth slag is practically as effective, unit for unit, as the old Bessemer slag, while the low-soluble slag is less effective. But when one steps down from broad principles to actual details the results show considerable complexity. In some

TABLE I.

COMPARISON OF FERTILISER VALUES OF MURIATE OF AMMONIA WITH SULPHATE OF AMMONIA CONTAINING EQUAL QUANTITY OF NITROGEN.

1.—*Muriate of Ammonia apparently superior to Sulphate.*

Centre.	Crop.	Yield per Acre.		' Yield from Muriate when that from Sulphate = 100
		Muriate.	Sulphate.	
Rothamsted .	Barley, grain .	2238 lb.	2056 lb.	108·9
	,, straw .	24·7 cwt.	22·8 cwt.	108·3
Snotterton Hall, Durham .	Potatoes.	14 t. 15 c. 23 lb.	13 t. 1 c. 67 lb.	111·7
2.—*Muriate apparently equal to Sulphate.*				
Aber, near Bangor. Single dressing, .	Mangolds . .	25 t. 8 c.	25 t. 8 c.	100
Do., double dressing, .	,,	25 t. 6 c.	27 t. 0 c.	93·7
3.—*Muriate apparently inferior to Sulphate.*				
Rothamsted .	Wheat, grain .	1556 lb.	1605 lb.	96·9
	,, straw .	23·8 cwt.	25·8 cwt.	92·3
Snotterton Hall, Durham .	,, grain .	64 bush.	64 bush.	100
	,, straw .	57 cwt.	62 cwt.	91·9
Ebchester, Durham . .	,, grain .	53¾ bush.	59¼ bush.	90·7
	,, straw .	46 cwt.	50½ cwt.	91·1
Ebchester, Durham . .	Potatoes . .	11 t. 4½ c.	12 t. 18 c.	87
Seaton Delaval, Northumberland	,, . .	7 t. 11 c.	9 t. 2 c.	83·0
Ebchester, Durham . .	Seeds hay . .	46¼ cwt.	51½ cwt.	89·8
Hebron, Northumberland .	Oats . . .	27 bush.	30 bush.	90·0
Dauntsey School, W. Lavington, Wilts . .	,, . . .	69 ,,	78½ ,,	87·9
Harper Adams Agric. College	Mangolds (all at seed time) .	31 t. 19 c.	35 t. 4½ c.	90·4
Harper Adams Agric. College	Mangolds (half at seed time, half at thinning) .	33 t. 3 c.	35 t. 4¾ c.	94·1

conditions the low-soluble slag is only little inferior to the high-soluble; in others it is considerably inferior. Some of the results are shown in Table II. As in the case of muriates *v.* sulphates, it is necessary for the agricultural investigators to define exactly the conditions under which the low-soluble slag is effective so that he can give information of solid value to the farmer.

TABLE II.

EFFECTIVENESS OF VARIOUS BASIC SLAGS.

1. *High Soluble Slag superior to Low Soluble.*

Centre	High Soluble Slag		Low Soluble Slag		Unmanured	Yield from Slags, when that of unmanured = 100	
	Solubility Per Cent.	Yield Cwt. per Acre	Solubility Per Cent.	Yield Cwt. per Acre	Yield Cwt. per Acre	High Soluble	Low Soluble
Saxmundham, Suffolk—							
Old grass, 1914-17 .	95·3	53·5	45·7	40	36·5	146·6	109·6
New ley, 1914-17 .	95·3	32·5	45·7	25	21·25	153·0	117·7
Martins Hearne, Essex —5 years, 1917-21 .	91·2	27·2	20·1	21·3	16·1	169·0	132·3
Lambourne End, Essex —3 years, 1919-21 .	80	30·1	32	26·5	17·7	170·1	149·7
Cockle Park—12 years, 1908-21 . . .	93	21·5	66	19·5	7·5	286·7	260·0
2. *High Soluble Slag not superior to Low Soluble.*							
Tysea Hill, Essex—4 years, 1916-19. .	93·4	32·8	45·0	32·8	22·8	143·9	143·9
Latchingdon, Essex—5 years, 1916-20 .	93·4	28·9	45·0	28·9	20·5	141·0	141·0
Lambourne End, Essex —3 years, 1919-21 .	91	30·6	20·0	33·3	17·7	172·9	188·2
Wenden, Essex—5 yrs., 1916-20 . . .	93·4	35·5	45·0	39·9	30·4	116·8	131·3

During the course of this work it has been shown that the official test for solubility is not entirely satisfactory. It was invented to detect a fraud which was at one time practised—the selling as pure slag of a mixture of mineral phosphates with Bessemer slag, and it served this purpose so well that it became generally adopted. It is now used for the wholly different purpose of evaluating slags, for which, however, it is not entirely suitable. Since it was introduced pure chemistry has made notable advances and a more satisfactory test could now be devised.

The work on basic slag has, however, revealed another problem of even greater difficulty. When careful stock was taken of possible supplies of slag and of farmers' requirements it was found that there was not, and probably never would be, sufficient to go round. The figures for the production of basic slag suitable for fertiliser are given in Table III.

The farmer is becoming more and more alive to the necessity for using slag: in 1913 he allowed 116,000 tons of the available high-grade slag to be exported to foreign farmers; in 1920 he not

TABLE III.

PRODUCTION OF BASIC SLAG IN THE UNITED KINGDOM.

Phosphate Content	Pre-War, 1913. Production.	Production for 12 months ending Sept. 30.		Expert estimate of quantity that could be consumed annually.	
		1920.	1921.[1]	Sir T. H. Middleton.	Sir A. D. Hall.
	Tons.	Tons.	Tons.	Tons.	Tons.
Over 33% . .		46,229	14,504		
26—33% . .		121,357	47,366		
22—26½% . .		90,928	61,400		
15½—22% . .		302,340	186,649		
Total useful slag	374,000	560,854	309,919	890,000	975,000
11—15½% . .		118,011	50,294		
Under 11% . .		22,522	16,968		

only used all that was produced, but imported 6,400 tons from abroad; while in 1921 the excess of imports over exports rose to 38,500 tons. But the supply is still far short of what we should like to have.

The Ministry of Agriculture Committee have carefully enquired whether any alteration could be effected in the steel-making processes to increase output, but without success. Fortunately, however, a partial substitute has been found in finely ground mineral phosphates, which, under some conditions, behave almost like slag, though under others they are definitely inferior. Again, therefore, the investigator has to discover exactly what conditions are suited to the mineral phosphates and what are not.

Those whose memories go back to the eighties will recall the great battle of the phosphates, started by that redoubtable fighter Thomas Jamieson of Aberdeen, and may wonder why the modern workers are traversing the old ground all over again. But they are not doing so. The modern problem is not mineral phosphates *v.* superphosphate as in those days, but mineral phosphates *v.* modern open hearth slag, which is quite a different matter.

We hope ultimately to map out the country to show those regions in which mineral phosphates can be used with reasonable hope of obtaining nearly as good a result as with slag, and the other regions where the chances are against the mineral phosphates. Similarly the country could be mapped out for muriates as against sulphates, and for low soluble as against high soluble slag.

It might be urged that our erratic weather makes sharp divisions impossible, but it is easy to exaggerate this difficulty. If farmers were concerned with one year only there would be some force in the objection, but most of them are working over a run of years, and in spite of great variations there are certain weather characteristics that turn up fairly regularly in each district. The effects of weather are being studied closely by the Statistical Department at Rothamsted. A few facts are already known which afford some help to the farmer: it is proved that the yield of winter corn is likely to suffer after a wet winter, and therefore an early dressing of nitrogenous manure is desirable. In many cases the damage comes too late to be rectified, but it should be possible to give farmers an early warning of what is likely to happen so that they may make their plans accordingly. The Life Assurance Companies have to deal with one of the most uncertain things on earth—human life—yet they have reduced their business to an exact science, and there is no reason why similar methods should not give great help to agriculture. Work of this kind is being done at Rothamsted; it is urgently needed in Scotland also, where as is well-known the trained statistician already exists.

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[1] The production in 1921 was affected by the coal strike, trade depression, etc.

Sewage.—Two other fertiliser problems only need be mentioned. One is the utilisation of sewage. Ever since Great Britain made the great step of introducing water carriage for sewage instead of the old pan or earth devices it has been a cause for regret that such valuable fertiliser material should be wasted. More than sixty years ago Liebig wrote "It is impossible that such a sinful violation of the Divine Laws of Nature should for ever remain unpunished, and the time will probably come for England sooner than for any other country, when, with all her wealth in gold, iron and coal, she will be unable to buy one thousandth part of the food she has, during hundreds of years, thrown recklessly away." This was an exaggeration but it contains an element of truth.

At present the value of the excrements of the population of the United Kingdom exceeds £17,000,000 per annum. For years chemists have tried to utilise this material and now a beginning has been made; the activated sludge process yields a sludge containing about 15 per cent. of the manurial constituents of the sewage, and needs only suitable drying to become a high class fertiliser.

Farmyard Manure.—The other problem relates to farmyard manure, the oldest and still the most generally useful manure available. Careful study at Rothamsted of the processes going on in the dung heap has shown that they can be repeated without the intervention of animals, and a heap of straw can now be converted into quite presentable looking farmyard manure by the simple expedient of supplying the necessary ammonia, water and air. This process is now being operated on a semi-commercial scale and some large demonstrations have been arranged in Essex and other counties where quantities of straw are available.

Tillage.—A more difficult range of problems is set by cultivation. Any farmer who keeps account books knows that a large part of his expenditure is on cultivation, and it is here that he must look for possibilities of retrenchment when he carries his Geddes' axe about his own farm. Machinery will ultimately do it, but how can matters be hastened? Nowadays one cannot afford to wait until the proper machine turns up; some bridge is needed between the farmer and the implement maker. The first thing necessary is to find out exactly what the farmer wants, or to be more precise, just what work the machine is intended to do. Now in the case of cultivation implements this is more difficult than it appears. The farmer knows in general that he wishes to obtain a good tilth, but no one can put this into precise language such as would enable an engineer to devise a suitable implement. Even such elementary problems as the most desirable speed for ploughing, the variation of resistance with moisture content and nature of soil, effect on draw-bar pull of slope, of depth of ploughing, of previous treatment of the land are all unsolved, whilst the most fundamental factor of all—the nature of tilth—remains unknown. Compare the position of an agricultural implement maker with that of a ship builder who has at his service a mass of most precise information as to pressures, resistances and many other matters essential to his craft. Indeed, one might find a comparison much nearer home, for if one compares the implement maker with the fertiliser manufacturer the advantage is all in favour of the latter; manuring is now a science, and the expert can draw up a manurial formula and the manufacturer can supply it exactly; he can even offer the farmer a choice of substances of different prices, different effects on the soil, etc. There is no reason why cultivation should not become a science and there is little doubt that when it does it will undergo remarkable developments.

Plant Breeding and Diseases.—All the factors discussed so far alter the natural conditions of the soil and make them better for the plant, but after a certain stage the attempts to improve on nature become too expensive, and it is better to alter the plant to make it fit the conditions. Fortunately agricultural plants are plastic, they can be altered by cross-breeding, and hosts of varieties can be produced. This improvement has been going on for generations; cultivated wheat for many years past has been widely different from wild wheat. But the improvement of crops has developed enormously of late years, due to the theoretical work of Mendel, Bateson and others, and its practical application by Biffen to wheat, Wilson to potatoes and by others. Still more rapid development is foreshadowed by the new and important Plant Breeding Stations at Cambridge, Edinburgh and elsewhere. The advantage of having a wide selection of varieties has been remarkably illustrated by the history of Wart Disease in Potatoes. This terrible disease threatened to reduce considerably the value of the potato crop, and there is no known way of curing it; once the soil is infected it remains so for years, and a very slight infection is capable of doing an indefinite amount of harm. Fortunately among the multitude of varieties of potatoes some are immune. This is of extraordinary scientific interest; in no other case at present known are varieties immune, but only more or less resistant. But the scientific interest is overshadowed by the

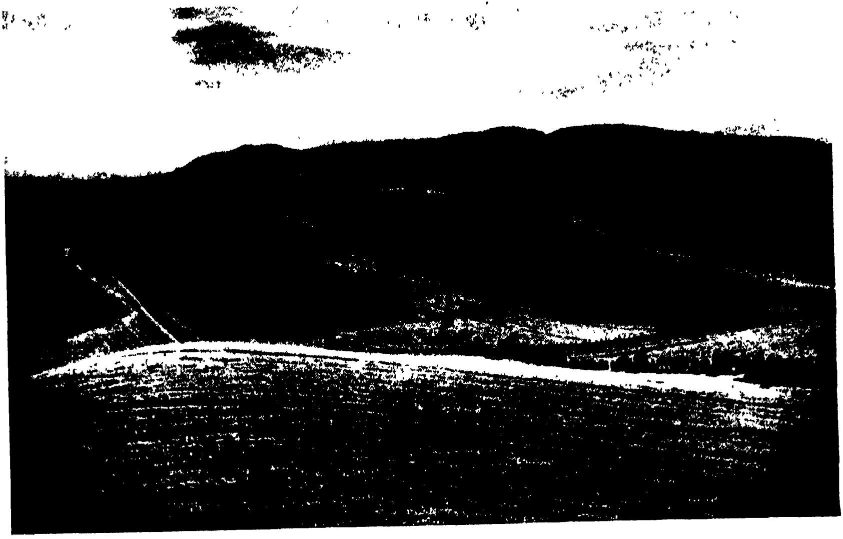

Plate I.

Drumlin (X) photographed from top of another drumlin (XX). In the hollow is a dry lake flat (L), (nr. Doune, Perthshire).

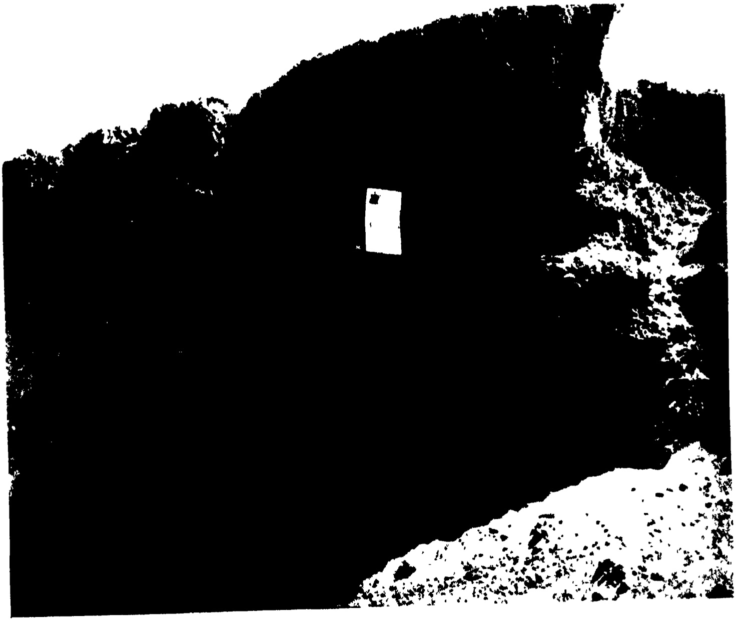

Plate II.

Section of soil and subsoil of a Kame, showing about twenty-three inches of pebbles and sand on water washed sand (one mile west of Drymen, Stirlingshire).

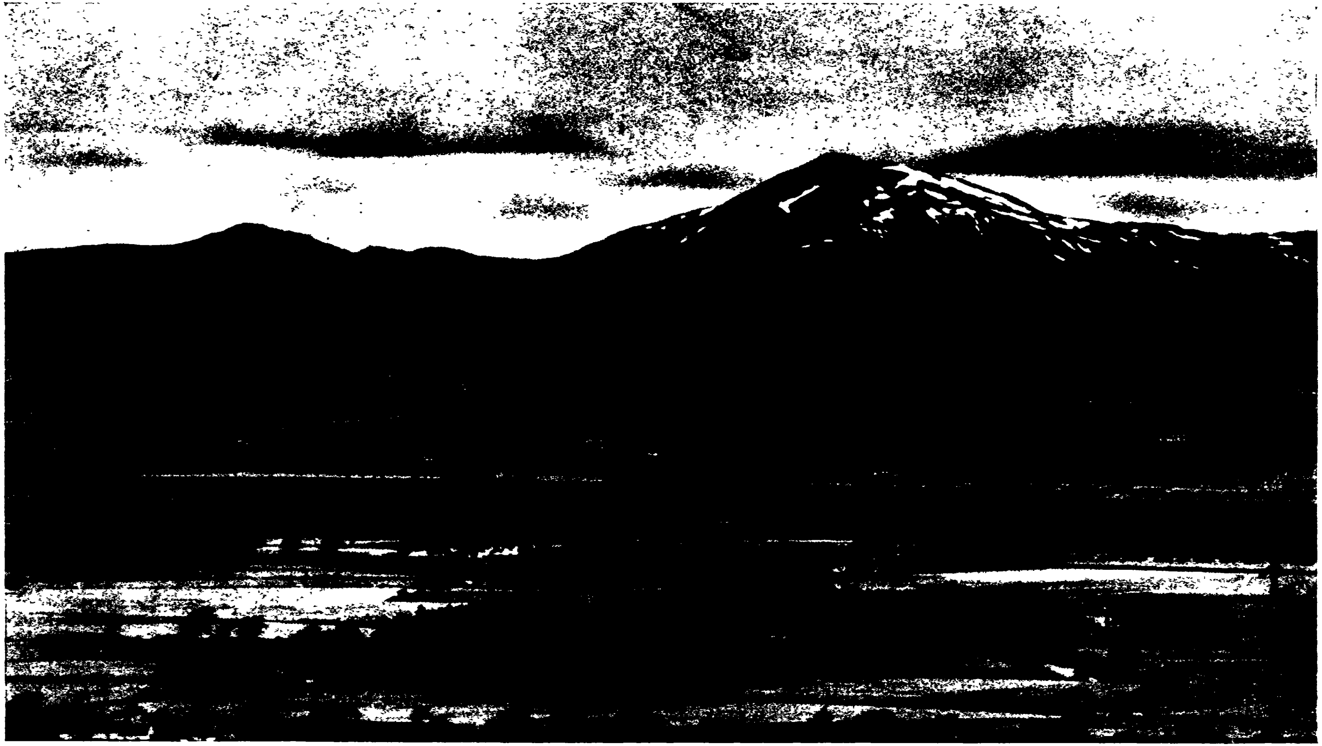

PLATE III.

Telephoto from Cauldhame, Kippen, across Flanders Moss to Ben Ledi showing a carse (flat) occupied by carse clay (C) and deep peat of Flanders Moss (M). L is medium sandy loam. Con. (Ridge of hard conglomerate with pockets of loam distinguished by bracken. S Highland Schists rising to Ben Ledi.

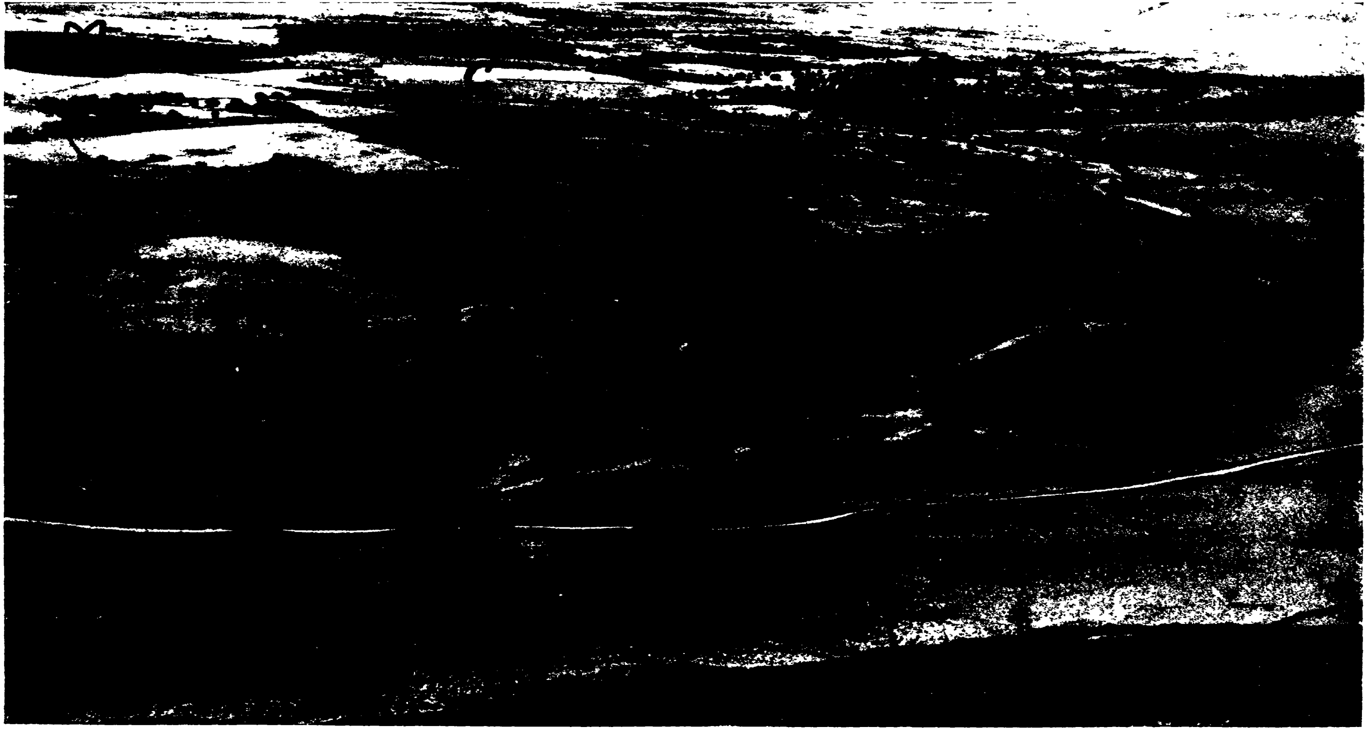

PLATE IV.

Kames of sand and gravel (K) forming winding ridges and hummocks near Aberfoyle. C is carse clay, M deep peat. This photo-map shows the irregular distribution of fluvio-glacial deposits.

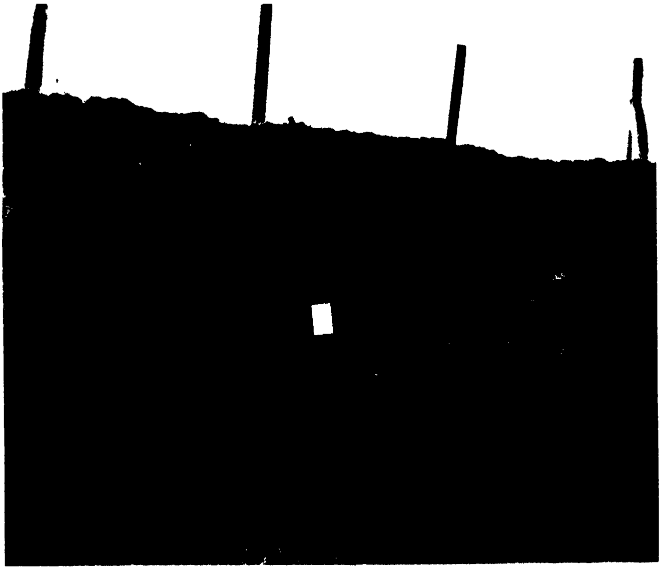

PLATE V.

Thin Brashy loam on basalt (S. Ayrshire).

PLATE VI. —"WHIN" SOIL.

Soil of Plate V. as seen in the field a friable chocolate-brown loam containing numerous *angular* fragments of the parent rock.

practical importance of being able to avoid the trouble altogether by substituting immune for susceptible varieties. There is little doubt that this discovery has saved the potato industry in many districts.

Great strides have been made in the development of cereals, but still further improvements are probable. Both in cultivation and in manuring the best farmers are already ahead of their best varieties, and in many cases if a man did all he could the crop would simply go down. Few improvements in crop production would be more effective than the production of a stiffer straw. Biffen is steadily doing this for wheat and Beaven for barley.

Reference has already been made to wart disease of potatoes. Until recently little attention was paid to plant diseases and they were simply tolerated as unavoidable misfortunes. No reliable estimate can be formed of the losses suffered by farmers through diseases and insect pests, but it must run into millions of pounds sterling every year. In 1906 the gross value of farmers' crops was estimated at £125,000,000; to-day it cannot be much less than double (owing largely to difference in values), and a small percentage loss means in the aggregate a large sum. Much of this could be saved and, we hope, will be saved, when more is known about plant diseases. A department has been set up at Rothamsted and a promising beginning made.

Soil Organisims.—We have not touched on a field which holds out great possibilities for the future. The soil is inhabited by a vast population of living organisms which play a highly important part in soil fertility. They are, however, microscopic in size, and it is physically impossible to watch them at work in the soil, so that they have to be studied by indirect means; such methods are now being devised. It is known that some of these organisms produce plant food; others break down useless cellulose to form valuable humus. Others again consume plant food (this particular activity is not useful), while some prey on certain of their neighbours, and others cause plant diseases. Something is known about these activities, but the details are all obscure.

It would be a mistake to suppose that this population is in the soil for the express purpose of helping plants to grow, and there is direct evidence that a simpler population would give better results. It is hardly likely that any practicable method of control will be reached in the near future, but yet the problem has to be solved. When we remember how much has been done to improve plants and animals we cannot despair of improving the soil population; and although the first steps may give no practical return they are essential to any advance.

Conclusion.—It would be easy to dwell on other ways in which science is helping the farmer to grow crops. Perhaps the greatest of all is the knowledge that it gives him of the soils and crops to which he devotes so much of his time, the interest that is imparted to the "daily round" when a man knows *why* he is doing what he does, and the possibilities of improvement when a keen farmer knows exactly what he is seeking to do and from what directions he is likely to obtain help. It is only when this knowledge has been won, carefully tested and classified, that it can be used. As Sir T. H. Middleton has well said, "The first essential for the improvement of agriculture is the improvement of the farmer himself."

One last consideration:—*Great strides have been made by inventors in other industries, but there has been little chance yet in* soil management. No invention ever arises spontaneously; it depends on a full knowledge of the properties of the materials concerned. Had the inventor of the motor car lived a hundred years ago he could not have made his invention; the car could not arrive till mathematicians had developed certain methods of working out formulæ, till chemists had discovered the laws of combustion, till metallurgists had produced certain alloys and engineers had studied the properties of rapidly oscillating bodies; all this and much more abstruse academic work had to be done before a single motor car or tractor could be made. This kind of fundamental knowledge is being gained in agriculture, but the process is slow and the machinery necessarily complex, including Universities, Experimental Stations and many detached workers in the counties. At all cost the work should continue. The poorer a man the greater is his need for knowledge; and what is true of the individual is equally true of the nation. We are improverished, but that makes it all the more necessary that we should learn all we can of the laws by which the earth yields her increase.

THE FIELD STUDY OF SCOTTISH SOILS.

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THE systematic examination of soils and subsoils, as they occur in the field, is one of the most useful and interesting developments of geological science in recent times. Many people regard geology as the mere collecting and labelling of rocks and fossils. But the fertility of the soil is largely determined by its composition and subsoil, and the study of the origin and qualities of these leads us right down to the parent rock. Just as there is a geology of coal-mining, of metallic ores, of oil-bearing rocks, of building stones, of road metals or of water supply, so there is a geology of soils, subsoils and substrata. This division of the science is now commonly referred to as Soil Geology.

ROCKS.

Since most soils are more or less derived from broken and weathered fragments of rock with rock-meal and rock-dust, it is essential for a proper understanding of the subject to know something of the rocks themselves—of the raw materials from which nature has manufactured our soils.

With respect to origin, rocks fall into three great divisions—Igneous, Sedimentary, and Metamorphic.

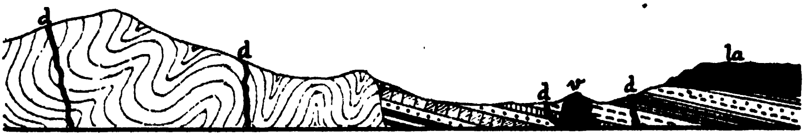
Igneous Rocks.—These have formed by cooling from a molten condition as does lava when it flows forth from a volcano. The first crust of the earth was composed of igneous rocks. In Scotland there are many varieties of this class of hard, crystalline rock, sometimes disposed in sheets to form upland plateaux like the Campsie Fells or the Ochils, sometimes occurring in great round bosses, as in the Galloway Hills, or rising to the mountainous heights of Goat Fell or Ben Cruachan. Two types of igneous rock which are important as soil formers are basalt and granite. Basalt, the "whinstone" of the quarryman, is a dark green or black rock, rich in the bases iron, lime, and magnesia; granite is lighter in colour than basalt, usually grey or red, containing a high percentage of silica and a small proportion of bases.

Sedimentary Rocks.—These occur in layers or strata, as may be seen in a sandstone or limestone quarry. The first rocks of this type were derived from the weathering and denudation of the original igneous crust of the earth by rain and wind, frost and ice, rivers and the sea. The sand, clay, pebbles, lime, etc., washed into that great settling pond, the sea, were sorted out by the waters into layers at the bottom. Under the influence of pressure, heat, and cementing material in the sediments they became harder and more compact. Finally they were, here and there, raised to the surface to form dry land. Such briefly is the origin of the stratified rocks, the sandstones, shales and limestones. In the graphic words of John Burroughs, "the primeval granite was their father and the ocean was their mother."

Metamorphic Rocks.—In the remote past the crust of the earth was much more restless than it is to-day. At the present time we are much surprised when we hear of school boys being shaken from their seats at Crieff or Comrie when the "solid earth" trembles along the old boundary fractures. But the testimony of the Highland schists tells us of a time when extensive and ever-recurring foldings and overfoldings and bucklings of the earth's crust were everyday affairs. Such movements, in the crust of our contracting globe, acting on rocks at high temperatures and charged with warm solutions, gave rise to the metamorphic rocks. Soft shales became altered to hard slates or silvery phyllites, sandstones changed to tough, steely grits, limestone was reconstructed as hard crystalline marble, and basalt as hornblendeschist.

Geological Map of Scotland.—Each of these great rock divisions is well represented in Scotland as the reader may see by looking at, say, Sir Arch. Geikie's Geological Map of Scotland (scale, 10 miles = 1″). This map is a coloured picture, showing the distribution of the rocks or foundation stones on which Scottish soils and subsoils rest. Granites and basalts are picked out in bright red and crimson lake, reminding one of their plutonic or volcanic origin. Gneiss, mica schist, slates, grits, quartzite, and other metamorphic rocks are dominant in the highlands and islands. The stratified rocks occupy the lowlands—the arable lands. Fig. 1 gives the geological structure of

FIG. 1.



■ IGNEOUS. ▨ STRATIFIED. ▩ SCHISTS. d = dyke. v = volcanic vent. la = lava plateau.

Scotland in little. It may be regarded as a section from Ben Lomond, across Strathendrick to the lava plateau of the Kilpatrick hills. The extinct volcano (v) may be the *fons et origo* of the lava sills and of the dykes (d) or sheets of igneous rock which pierce the schists and the strata. The schists, rising to over 3000 feet, represent the highlands, the stratified rocks are lowland, carrying a "rich red loam for the plough," and the igneous rocks form the upland sheep runs of Cochno and High Craigton.

SOILS.

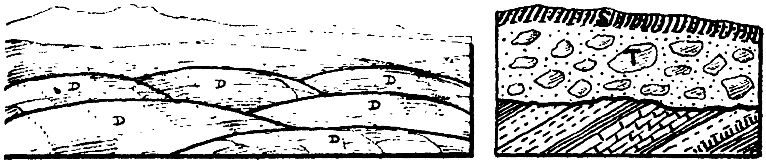
So far, we have described the rocky skeleton of the country; we turn now to examine the flesh with which these bones are covered. This usually takes the form of a mantle of till or drift or boulder clay, as it is variously called, covering the bed rock to a depth ranging from inches to hundreds of feet. The till on the north side of Glasgow is composed of a tough, purplish brown paste of pulverised sandstone, shale, coal, limestone, basalt, etc., in which is firmly embedded pebbles and boulders of rock of many kinds, some of them schists from the neighbourhood of Loch Lomond, twenty miles away. It is clear that the matrix of this boulder clay is derived from local sedimentary rocks crushed and compacted. And if we examine till in Argyll, Ayr, or Dumfries, we find a similar state of affairs. The till is a rock paste *derived from local rocks*, and the boulders mostly from distant hills.

Origin of Boulder Clay.—The explanation of the structure and variations of boulder clay can be easily understood if we consider the history of these islands during the Great Ice Age, when all Scotland lay under a thick sheet of ice, such as may be seen in Greenland or the Antarctic to-day. This ice sheet was not stationary but flowed slowly from the higher levels to the lower, exerting an enormous pressure on the rocks beneath it. Projecting rocks were plucked from their beds and incorporated in the moving ice, to form coulters and shares for the titanic ice-plough. The softer rocks were pulverised and the hard ones scored and reduced. Resistant rocks were carried far from their original locus. Under the ice a sheet of rock debris was formed containing scratched and facetted boulders. This ground moraine, below the ice, formed the boulder-clay. In the ice-sheet itself were disseminated similar materials.

"Kames."—Later on, as our climate grew less cold, the general ice-sheet decreased in size until only the mountain districts were ice covered. From these elevated areas radiated large glaciers, which flowed down the glens or loch basins to the lower levels, where they melted and dumped large quantities of boulders, gravel, sand, and silt in mounds and winding ridges (Pl. 1). These morainic and fluvio-glacial deposits form the poor light stony hillocks which have long been known in Scotland as kames, and we shall use that term in referring to them. In Lanarkshire, the glaciers from Culter Fell and Tinto, formed kames at Carstairs and Lanark, while similar formations exist in Dumfriesshire at Locharbriggs and south to Annan, in Perthshire at Gleneagles, and in Stirlingshire at Drymen. Someone has described such land as " the riddlings of Creation," and in a sense it is.

Glacial Lake Flats.—Besides the sow-backed drumlins of till (*see* Fig. 2 and Pl. 1) and the kames (*see* Fig. 3), the glaciers gave rise to a third class of land—the Glacial Lake Fats. Occasionally during the Glacial Period a glacier dammed back a river and formed a lake (*see* Fig. 4). This lake became a settling pond

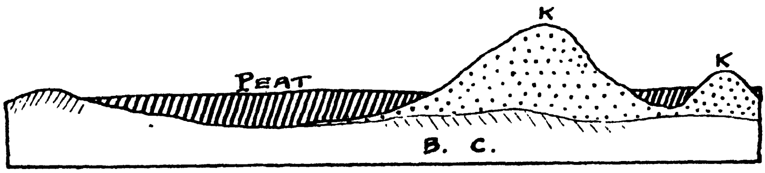
FIG. 2.



"BASKET OF EGGS" TOPOGRAPHY, DUE TO THE ARRANGEMENT OF BOULDER CLAY IN SOW-BACKED RIDGES OR DRUMLINS (D).

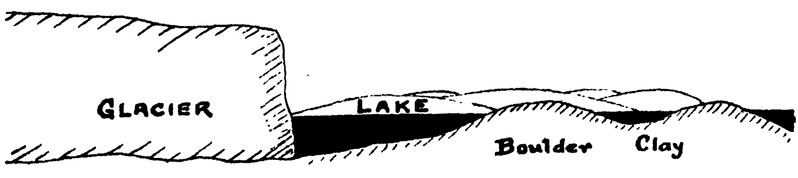
SECTION OF A DRUMLIN SHOWING SOIL AND SUBSOIL (S) ON TILL (T), ON ROCK.

FIG. 3.



SHOWING RELATIONS OF KAMES (K) PEAT AND BOULDER CLAY (B.C.)

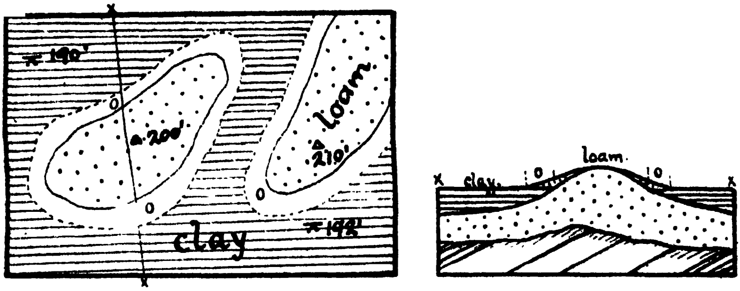
FIG. 4.



SECTION SHOWING HOW A MARGINAL GLACIAL LAKE IS FORMED.

for the sand and mud carried by inflowing streams, and in time came to contain a considerable amount of sediment. After the ice vanished the glacial lake flat remained with the river flowing through it and eroding it. In Fig. 5 is a map of some twenty

FIG. 5.



SOIL MAP OF PART OF GLACIAL LAKE FLAT SHOWING "ISLANDS" OF BOULDER LOAM RISING OUT OF CLAY FLAT. O= OVERLAP.

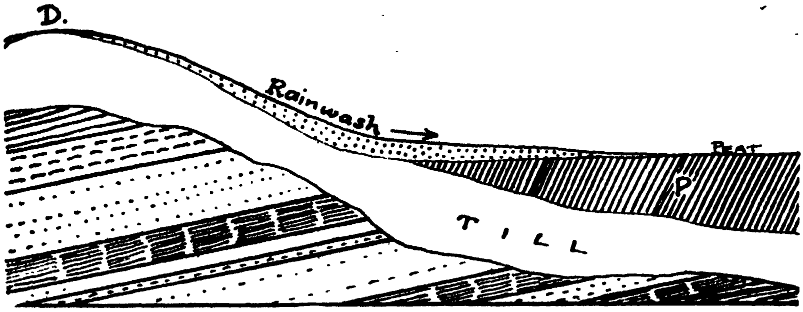
SECTION ALONG LINE XX. RAIN-WASH FROM LOAM RIDGE OVERLAPS LAMINATED CLAY OF LAKE FLAT AT O.

acres of one of these flats. The boundary of the clay follows the 190 feet contour line round islands of sandy drift. The rainwash from the isolated drumlins overlaps the clay at O, forming a sort of "aureole" round each ridge. This is a wet belt —a line of springs.

I have referred in the text and in Fig. 2 to the arrangement of the till in drumlins or drums. These are very numerous in Scotland as is reflected in such farm names as Drumbuie, Drumdow, or Drumquhassle. It is evident from the topography of a drumlin district that lochs will form readily among these ridges, and in Scotland many hundreds of such lochs have existed. Some may be seen now, others have been silted up to form marshes, or drained to provide meadows and rich arable land. It is beside such flats that we find farms bearing names like Boghead, Meadowhead, or the Grange. The soils of dry lake flats are varied: one may be clay, another peat, a third loam, while a fourth may contain every soil imaginable. In the Old Red Sandstone area of Carrick we usually get sandy loams of great depth with some peat; in Kyle the fine clay of the heavy red till washes into the flats as tile clay; in Dumfries, peat on grey sand is common. In Fig. 6 is seen a section across a lake flat at Maybole, showing loamy soil washing from a drumlin out over peat, which ranges to ten feet in depth.

Soil Creep.—In Fig. 6 I have referred to rain wash, *i.e.* the creeping of soil down a slope under the influence of water. Soil Creep (solifluction) is a slow process, depending on (1) the steepness of the slope on which the soil is lying, (2) the rainfall, (3) frequency of freezing and heaving up of the soil. Soil which is regularly in cultivation washes more readily than that in pasture. One effect of soil creep is to accumulate deep soil round the base of a drumlin while the top may be nearly "bald" of soil. Among stratified rocks rain wash may carry poor sand from a sandstone outcrop over a fertile limestone, or *vice versa.* In highland districts the effects of rain wash are very marked along the base of steep hill-sides, where they may be associated, as in Argyll, with talus slopes and landslides. Such land is always deep, and often wet and peat covered.

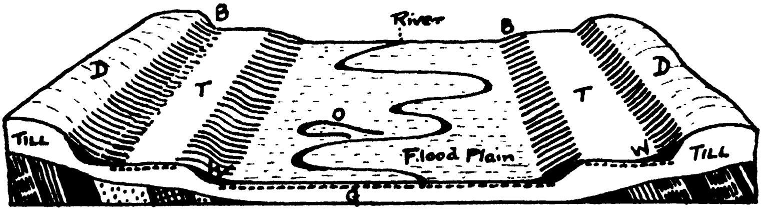
FIG. 6.



SHOWING RAINWASH FROM A DRUMLIN (D) SPREADING OVER PEAT (P) NEAR MAYBOLE.

River Valleys.—Many of our most fertile soils—deep rich loams—lie along River Valleys. In Fig. 7 is shown in section and perspective the general arrangement of soils due to river action. On either side, the valley is bounded by drums of till and by flat benches or terraces (TT), which are level with each other. On the lowest flat is seen the river meandering along its flood plain. The flood plain and the terraces are bounded by steep banks (BB). At O, the river has amputated one of its loops, leaving a wet U-shaped depression, an ox bow. The flat of river alluvium along which the river winds is here composed of two feet of sandy loam resting on a subsoil of gravel and sand. Such an alluvial flat has been made by the river, which not only cuts downwards but, in the course of time, saws horizontally from one side of its flood plain to the other. The terraces (T) are remnants of a higher flood plain which has been eroded by the stream after an uplift of the land, which has increased its velocity and cutting power. In areas covered by till or kames rivers lay down broad and extensive alluvial flats and terraces; in sandstone and the

FIG. 7.

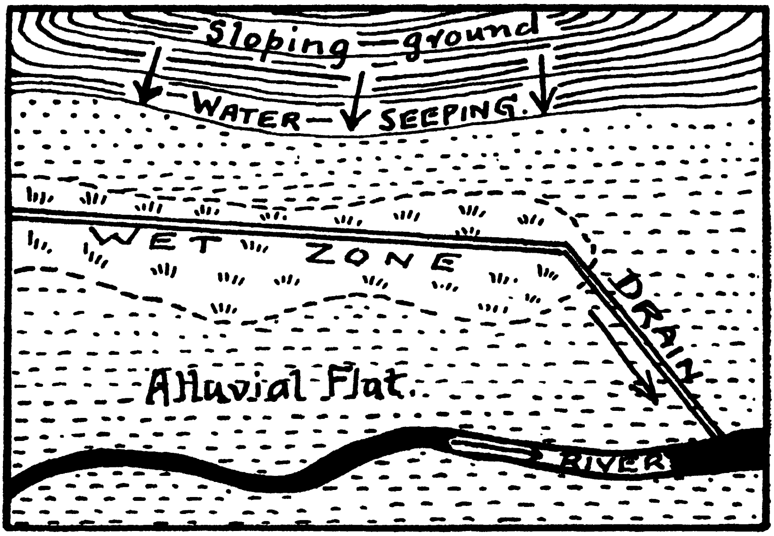


SOILS DUE CHIEFLY TO RIVER ACTION. FLOOD PLAIN GRAVELLY ALLUVIUM (G) REPEATED ON TERRACES (T.) D=DRUMLIN OF TILL. W=RAINWASH OFF BANKS (B). O=AN OLD RIVER CHANNEL OR "OX BOW."

like, the river may cut a gorge or cañon. The extent and depth of alluvial land increase as we pass from the source to the mouth of a river: the alluvial haughs of the Nith are more fertile near Dumfries than at Kirkconnel.

These river-laid soils are usually stratified and show all the signs of river deposition. They are washed from the rocks and drift of the river basin and vary accordingly. In Scotland the commonest type is a brown sandy loam. On the Annan water near Lochmaben the alluvium is a fine silt loam, on the River Ayr at Auchencruive it is a deep red and sandy loam, in the links of the Forth the alluvium is "inlaid" in carse clay as a deep silty clay loam, "worth a king's ransom." The soils of the terraces are usually coarser than those of the flood plain, and contain less humus. Each terrace on the side distant from the river (Fig. 7, w) receives rain-wash from the till above it. The ground water tends to move towards the lower terraces and the flood plain, often causing a wet zone to form along the edge of the latter: such water may seep right across the haugh and should be removed by an intercepting drain (Fig. 8). This "cut off" drain must be filled in with pervious material (sand, gravel, etc.) so that *the ground water may flow along it rather than across it.*

FIG. 8.



DRAINAGE OF A WET STRIP ON ALLUVIAL FLAT, CAUSED BY SEEPAGE FROM ADJACENT BOULDER CLAY (AFTER ELLIOT).

Flood Plains.—Farmers, whose land lies on Flood Plains, know that these holms are places where water "has been and may be again." Flooding may be aggravated, as in the Kelvin valley, by subsidence of the underlying rocks after coal-getting or congestion of the main drainage outlet. Increase of hill draining has made most of our Scottish rivers more liable to sudden and disastrous flooding. In cases like the Kelvin valley and the River Annan, above Lockerbie, hundreds of sour and sodden acres could be drained by deepening the outlet of the main drainage artery.

Maritime Soils.—It is when we approach the shore line of this country that we find the most varied and intricate arrangement of soils. On the coast of Ayrshire or Wigtown one may cross in a few hundred yards from wind-blown sand to heavy clay and deep peat. The main foundation of these deposits is a series of platforms 15 to 120 feet above sea-level, following the coast-line and occasionally running inland for miles. These benches are the raised sea-beaches, marking former levels where the sea cut horizontally in upon the land. The rise of Britain "from out the azure main" seems to have taken place by instalments, and each uplift has left a record in the form of a raised sea-beach. Coast towns like Stranraer, Ayr and Rothesay are built on this platform and the Agricultural Show ground at Scotstoun stands upon it.

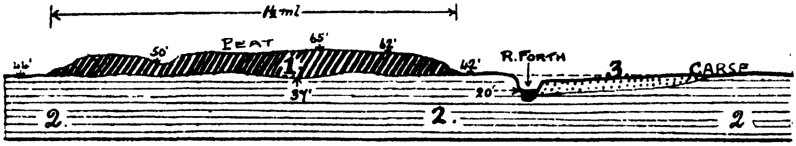
The writer has examined the soils of raised beaches for hundreds of miles round the Scottish coast and can testify to their variety. Along the shores of Ayrshire, Fife and the Moray Firth blown sands predominate near the sea. These sands may consist of moving dunes or fixed sandhills, or may be levelled to form early potato lands as in south Ayrshire. In Arran, Cantyre and Islay many of the raised beach sands lie under deep peat. Some of the sands are calcareous and shelly, as in Colonsay and at Machrie in Islay, others are devoid of lime. In many districts, Ayr for example, the sea-sand has blown inland for great distances to form a covering over heavy till, thus providing a valuable soil which is easily worked and not too pervious to water: from Alloway through Auchincruive to Barassie many of the soils are of this type. Other raised beach soils are gravels as in Islay and Arran, silt loams as in North Bute, stony peat loams as on Loch Linnhe, fine sandy and silt loams as at Loch Gruinart (Islay), etc.

Carse Lands.—These maritime soils are sometimes continuous with Carse Lands, such as occur on the Rivers Forth and Tay, or at the estuary of the Nith or Cree in the south. These carses are extensive flats of estuarine mud now raised twenty feet to fifty feet above sea-level. The discovery of skeletons of large whales and beds of oyster shells in the carse of Stirling remind one of times when the waters of the sea extended inland to Menteith and Gartmore.

Carse lands are composed in the main of fine silty clay ranging to a thickness of eighty feet or more. The surface soil on this deposit is a grey-brown stoneless clay: the subsoil is mottled with brown, olive-green and rusty yellow tints; deeper still comes fine sediment of a striking "horizon blue" colour. The soil colour denotes lack of humus; the subsoil tints are due to hydrated forms of hæmatite (red oxide of iron Fe_2O_3), such as orange-coloured limonite ($2Fe_2O_33H_2O$) and the yellow limonite ($Fe_2O_33H_2O$). Carse clays may be black and rich in humus where peat has been cleared from the surface, leaving six or nine inches of peat to be incorporated with the heavy subsoil. Such land when limed and properly drained is most productive, especially in wheat, beans or timothy. But many of our carse soils to-day are suffering from inefficient drainage and lack of lime.

The general level of a carse is broken by shallow depressions while stream courses cut canals here and there. In the carse of Stirling runs the sluggish Forth, oozing gently along between high banks of clay. This river in its meandering has eroded the carse clay and "inlaid" in it many links of fine silty red loam ("red carse"), *see* Fig. 9. The surface of this red carse is slightly lower than that of the "blue carse" hence the local saying, puzzling the geologist, that "the red carse lies below the blue carse." The red carse is highly valued and is said to graze a bullock to the acre. As we trace these soils towards the mouth of the Forth we see a gradual and marked improvement in their fertility.

FIG. 9.



SECTION ACROSS PEAT MOSS IN VALE OF MENTEITH SHOWING—1. PEAT, 2. "BLUE CARSE" CLAY AND 3 "RED CARSE." HEIGHTS (ABOVE SEA LEVEL) IN FEET.

Peat.—Squatting on 10,000 acres of this fertile land and completely obscuring it, lies the hideous form of Flanders Moss. Deep peat of this type is not uncommon on Scottish carses; a similar moss blots out a large part of the Carse of Cree. The writer has put down hundreds of bores in this moss to ascertain its relation to the subjacent clay. With the help of Mr John Malcolm, B.Sc., and some students from the West of Scotland Agricultural College, levels were taken across the moss and cross sections plotted. The moss is not a pleasant place in winter, when the surveyor reads his levels with bog water oozing into his boots and the surface swaying up and down at every step. He needs no analysis to convince him that a deep undrained moss contains 91 per cent. of water and is really a loch masquerading, in peaty guise, as solid land! The results of levelling and boring are condensed (not to scale) in Fig. 9. It will be seen that the peat averages about 20 feet in depth along the 2600 yard section shown and that its lowest point is well above the December level of the River Forth. Many people are of the opinion that this moss sits in a basin of prodigious depth. The section shows otherwise.

The upper layer of peat in Flanders Moss, to three or four feet deep, are of a brown "moss litter" type. Below that is good black peat of high calorific value. Remains of birch and oak occur at two more levels in the peat. The surface except for a few strips of small birches across the centre and along the margin, is treeless and composed of sphagnum, heather, cotton grass and sedges. This sterile waste provides a sanctuary for wild geese, ducks, gulls and many other enemies of the farmer. In the chilly evenings of Autumn a dense mist hangs over it.

Moss Clearing.—In the later part of the eighteenth century Lord Kames cleared most of Blair Drummond Moss six miles west of Flanders Moss. In 1823, 130 acres of moss were cleared at Meiklewood, near Gargunnock. In these operations the peat was detached in blocks and floated in canals to the Forth, thence to the sea to the detriment of the Forth fisheries which led to prohibition of the practice. These "reclaimers" of a century ago were enthusiasts and men of imagination. They were scientific. In their operations they paid as much attention to psycho-analysis as to chemical analysis and engineering. Graham of Meiklewood urged his squads of Scotch and Irish labourers to fierce competition with each other; he compares his assault upon the moss to an infantry attack upon the trenches of an enemy, but pronounces his warfare as the more glorious, because "while the soldier is making food for worms, my men were making food for men." Flanders Moss awaits another Lord Kames.

Besides the deep mosses of the Forth Valley there are in Scotland many others of similar nature and extent. Many of these like Lochar Moss, Priestside Flow, Moss of Achnacree, Laggan and Bowmore Moss are near sea level. On higher ground are hundreds of others. Many of these mosses supply fuel, sometimes on a large scale, to crofters and villagers; others (Lagavoulin) are dedicated to Bacchus. It is to be hoped that these extensive peat resources of Scotland will soon be developed and utilised by chemist, engineer and agriculturist. Those who are interested in this matter should keep in touch with the published reports of the Fuel Research Board under the skilled direction of Sir George Beilby.

Moorland Peat.—In addition to the deep mosses, peat is very wide spread, as thin moor peat usually from a few inches to a foot in depth and varying greatly in agricultural value. Soils of this nature are common in the Western Isles down to sea level. On the mainland, they are usually found above the arable level, as on hill sheep grazings and mountain areas. Peaty loams, peaty sands and gravels, peaty clays, "muck," soils of U.S.A. occur in every county. Their fertility is largely dependent on proximity to the sea; a peaty loam in Lanarkshire is greatly inferior to the black loams of Lochindaal.

Soil Surveys.—The above sketch of the field relationships of soils and subsoils reviews a range of varieties as diverse as the farmers who till them. If we borrow some of the adjectives applied to soils by agriculturists, we may speak of fat and lazy clays, intractable, dour clay loams, poor feckless sands and gravels, and quick, clever sandy loams. Some soils are optimistic and never miss a crop, others are pessimistic like the clays which Lady Pithyal declared to "girn a' Simmer and greet a' Winter." It is obvious that the manurial and other requirements of these diverse soil types must vary greatly. It is a fact that our knowledge in this direction is sadly deficient and that lack of such information is hindering the application of science to agriculture. The remedy is a systematic study and stocktaking of our soil types. We must classify these, sort them out the one from the other and then prepare maps showing the geographical distribution. This is the work of a soil survey and in this research and exploration soil geology reaches its highest practical application.

A report on soil types in the West and South of Scotland, the areas mapped and suggestions for the practical application of this knowledge will appear in this Journal as a sequel to the present article.

THE BIOLOGIST ON THE FARM.—No. VI.

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Biology of Spring.—April is the monthof opening—of the earth, of the seeds, of the buds, of the early flowers, of the eggs and of the womb. The migrant birds return, sometimes to the farm where they were born the year before. The humble bees appear from their winter's rest in the mossy bank—the only survivors of last year's community; the hedgehog has long since reawakened from its hibernation. All the corners of the earth and of the waters under the earth are beginning to be full of young things—each often a fresh start in evolution, that is to say, with some new departure that may be of value. The sap ascends from the stores in the tree, and from the thirsty roots in their soil solution. From the wound on the birch we see it overflowing. Spring is the time of awakening on the part of many living creatures that have been resting through the winter in diverse ways—as seeds, as cocoons, as bulbs, as tubers, as buds, as adults. But it is also the time of marrying, pairing and mating—the beginning of altogether new lives.

March Hares.—The hare is not a timorous animal, for we may see a mother facing up to a weasel that has come too near her young. But it is very alert and circumspect ; it senses the countryside with eye, ear and nose from a well-chosen "form." It criss-crosses its tracks so that the fox is puzzled. It takes a flying leap out of and into its resting place. A noted observer tells us that if there be four or five young ones in the litter, instead of the usual two, the mother-hare shifts two of them to another nest. Cautious, indeed, is the hare, for everyone's hand is against it! Yet what do we see in the springtime—the caution thrown to the winds, the sex-instinct triumphing over self-preservation. We see the hares galloping over the ploughed fields, chasing one another in the open, leaping into the air, jumping over one another and kicking back, resting for a minute or two as if sulking, then up and off again to find a mate or a rival to box with. Only when they settle down do they put on the garment of invisibility. Otherwise they are reckless, and seem almost to court attention. We smile to one another and say "march hare."

Earthworms and Feathers.—The earthworms are very busy in the soft soil—burrowing in fresh places, bruising the earth to powder in their gizzards, and burying the surface with their castings, and burying the leaves that make the tunnels more comfortable and rot away into edible mould. They are the most useful animals in the world, having made and continuing to make the fertile soil. We have noticed several times that they take feathers down into their burrows, and sometimes the feather dragged in is so big that it sticks in the shaft, leaving the upper half striking out vertically. Just the other day a sparrow-hawk was daring enough to kill a chaffinch on our lawn in Old Aberdeen, and to devour it at a short distance from the windows. More interesting, perhaps, is the fact that by next morning the earthworms had begun to take quite a number of the little plucked-off feathers into their burrows. These would make the burrows more comfortable, but they could not be of use for food. We suppose that this illustrates what is sometimes called "blind instinct." It is instinctive in earthworms, which are literally blind, to drag in leaves, and they cannot be expected to draw the line very accurately between leaf and leaf-like. It is difficult to believe that they get much good out of leaves like those of the Scots fir, though they treat them effectively enough, gripping at the base, where the two needles unite. If we were earthworms we should similarly deal with sharp forks, dragging them into our cave by the base. This we should call "reason" if we acted from the first on general principles, or "intelligence" if we were dull enough to require to learn how to do the trick. The question is what word we should use when earthworms act so wisely. Is it a ready-made, inborn, hereditary instinct, or do the earthworms learn how to deal with difficult leaves? Even Darwin did not settle this point.

Flies and Snails.—Inside earthworms we sometimes find the maggots of some fly or other, which seem to be devouring the creature from within. We cannot agree with those who call this "parasitism," unless the term is used very vaguely. For it is not in the interests of a parasite to destroy its host—killing the goose that lays the golden eggs. Moreover, the maggot subsequently becomes an independent fly. Would it not be clearer thinking to call the maggot a beast of prey that devours its victim from within, while others work from without?

Keilin has recently gathered together additions to a previous list of cases where flies lay their eggs in snails or slugs, so that the molluscs are killed by the maggots. It would be interesting to watch for this sort of thing. Many of the flies which Keilin observed were of the flesh-fly and blue-bottle type. Agriculturally the observations are of some interest, for anything that checks the multiplication of snails and slugs is obviously to the good.

Winged Worker-Ants.—Everyone knows that worker-ants are almost universally wingless. The flying ants that we sometimes see are winged males following winged queens. But just as workers occasionally lay eggs, so workers occasionally show traces of wings—taking our thoughts back to the time when the distinction between fertile winged females (or queens) and sterile wingless females (or workers) had not been established. It should be noted that the embryo workers have vestiges of wings, it is the occurrence of traces of wings in *adult* workers that is so rare. The cases that have been recorded might be counted on the fingers of our two hands. But Mr Harlow Shapley, writing from the Mount Wilson Observatory, Passadena, California, reports an extraordinary case of the occurrence of vestigial wings in nearly half of the 1700 workers taken in two years from one nest. Why this remarkable harking-back should have occurred remains quite obscure, but it is a vivid instance of the way in which the past lives on in the present. Some (385) of the "wings" were veinless stubs; others (219) had indistinct veins; and a third set (132) were transparent, clearly veined winglets. It is of great interest that the vestiges form a perfectly continuous series from small protuberances to well-developed winglets with a venation approaching that of the queen. This lifts the veil a little, for it surely *suggests* that the racial loss of wings was a gradual, not an abrupt, process.

How Quickly does an Ant Run?—Socrates is said to have inquired into the distance that a flea could jump, so it is not trivial to ask how quickly an ant can run? Mr Shapley has made very careful observation on a Californian ant common on Mount Wilson which works ceaselessly day and night. The average live weight of the larger workers is about five-hundredths of a grain (140,000 to a pound), and that of the smaller type half as much, so the little creatures have not much to carry. At low temperatures the speed is 0·44 centimetres a second (10 inches a minute); when the temperature rises 30° C. the speed is 6·6 centimetres a second (150 inches a minute). The interesting point is, that the speed increases in almost precisely the same ratio as the temperature.

The Cuckoo Again.—At a time of year when the cuckoo is once more making itself heard, the old puzzles assert themselves. What does the shirking of parental responsibilities mean? How does the mother cuckoo effect her purpose? We welcome Mr Edgar P. Chance's fine cinematograph demonstration that in certain cases the mother cuckoo *lays* her egg in the chosen nest, and that she may previously make room by carrying off and destroying the egg that has a right to be there. That the laying which may occur in the meadow pipit is not the method always adopted, is plain from the occasional occurrence of the cuckoo's egg in such nests as those of the wren, the tree-creeper and the reed-warbler, where it would not be possible for the cuckoo to sit. But this is just the sort of thing we should be looking into at leisure moments at this season. As to the larger problem, it must be borne in mind that birds follow a certain routine of behaviour, partly instinctive and partly intelligent. They arrive in spring, they look out for a territory, they court and pair, they make a nest, they brood, they nurture and educate their young, and they say good-bye. Now, slight variations in this routine are not infrequent. Thus a bird may make two nests: a bird may use the nest of a neighbour; a bird may have two broods when one is the normal number; a bird may brood on dead eggs; a bird may forsake the nest without sufficient cause. Variations in the timing of events are not uncommon among animals. One chapter of the life-cycle may be telescoped down and another lengthened out; one train of activities may be exaggerated and another become rather perfunctory. In the most general terms, as Professor Herrick suggests, the cuckoo, which the schoolboy described as "the bird what doesn't lay its own eggs," illustrates a temporal variation—the telescoping of the incubation chapter. That the method pursued sometimes differs in detail is a hint that the variation is not yet very ancient. That the new departure has paid is obvious.

SCOTTISH PURE-BRED LIVE STOCK.

XI.—BLACKFACE SHEEP.

JOHN P. MITCHELL.

THESE sheep have been variously named "Blackface" and "Short" Sheep, on account of their physical peculiarities, "Mountain," "Heath" and "Forrest" Sheep on account of their habitat, and formerly "Linton" Sheep, as West Linton in Peebles-shire was at one time their principal marketing place. In Scotland they have the name of "Blackfaces" only, while in England the usual name is Blackface Mountain Sheep, to distinguish them from other English Blackfaced Sheep.

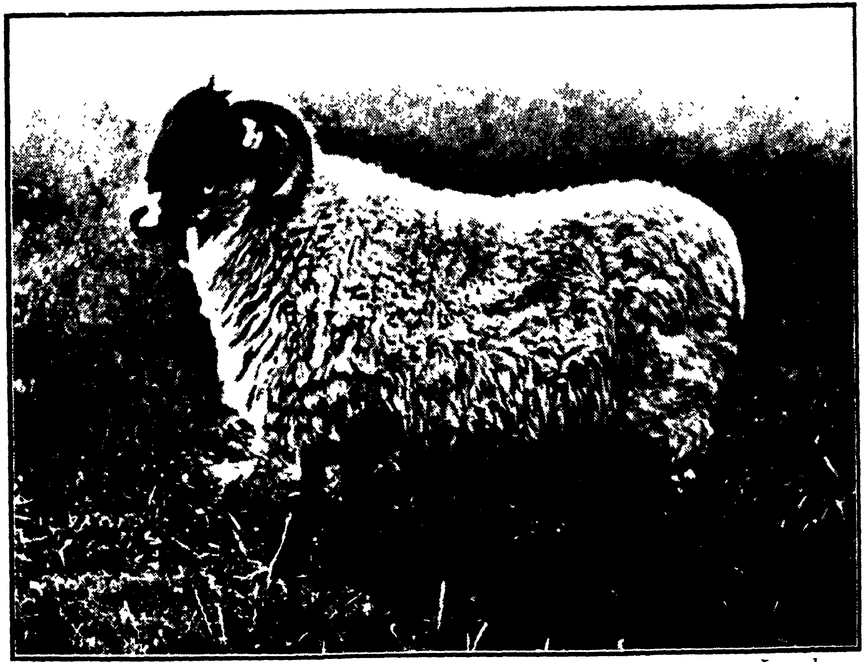
Historical.—The Sheep were described in 1804 as follows:—"The qualities of a good Ram are, long and high turned horns, long black face, forehead rough and slightly tinged with brown, chest straight and long, nose long and nostril wide, when nose is short and the nostril straight, it is certain sign of a dwarf, and when the face is a bare jet spreading directly to the fleece, it indicates that the distant posterity will be liable to adventitious spots. The forequarters deep and heavy over the shoulders, the neck should bend upwards a little, and should be well clothed with wool close to the horns and cheek, the back should be straight, shoulders a little higher than the back, the bend of the ribs wide, wide above the ears, which is a genuine mark of a true short sheep, and free from grey hairs in the tail." It may be added that, at this time, the wool was from four to five inches long.

In order to compare the above with the later description of the breed, the following description and scheme of marking for show purposes is given. It is taken from the "Blackface Sheep" by John Scott and Charles Scott, 1888 :—

HEAD :—Large and musculine, nose thick and slightly arched, nostrils expanding, muzzle broad and black, forehead broad, eyes large and bright, face covered with close hard hair, all black or black and white, the colours clearly defined and not running into each other	12
HORNS :—Strong and nicely curved, clear of the side of the head, about an inch apart at the roots, and not rising above the cantle	6
NECK :—Strong and slightly crested	4
SHOULDER :—Narrow on top and well filled up to neck	5
CHEST :—Deep and broad	12
BACK :—Broad, level and not too long	10
RIBS :—Well sprung and deep	7
HIND QUARTERS :—Wide, deep and fleshy	12
TAIL :—Set on level with back, strong and hanging well down the legs	2
FEET AND LEGS :—Feet large with open hoof, pasterns moderately long and sloping ; legs strong, especially from the knee upwards, of a black or black and white colour, and squarely planted under the body	5
WOOL :—Strong and thick in staple, twelve to twenty-two inches long, slightly wavy or curly and free from hairs or blue grey spots	15
CONSTITUTION, PEDIGREE, ETC. :—	10
TOTAL	100

The origin of the breed is doubtful. Some such as Youatt assert that it is of foreign origin, Low believes that it had its home in England and was taken from there to Scotland. Now the sheep are found all over the north of England and south of Scotland, while the Highlands of Scotland hold them in greatest numbers. It would now be difficult to prove definitely whether the sheep were of foreign origin or whether England got them from Scotland or the reverse, and so far as Scotland is concerned, it is only possible to say that, whether in the north or south of Scotland, they at one time formed only a small portion of the flocks of the country, and another type of sheep was regarded as the "Scotch" sheep. At the beginning of last century a south country writer states, regarding a light-faced strain of the breed, "they are descendants of crosses of the 'Blackfaced' with 'Cheviots' or the old 'Scotch' sheep, and are to be avoided."

It is usually stated that in 1503, James IV. had a large flock of Blackfaces in Ettrick Forest, and Sir Walter Scott states on the authority of some earlier historian that James V. had 10,000 of them there under the care of Andrew Bell of Fife, and that even at that time they proved a remunerative investment and added considerable revenue to the Royal Exchequer. Possibly owing to the fact that this man of Fife was in charge of the sheep, it has been stated that Blackfaces came from Fife, and it is at least worth notice, that



Brown, *Lanark.*

EWE, "EFFIE DEANS."

Five Shear. First in her Class at the Highland and Agricultural Show at Edinburgh, 1919, and winner of Silver Medal in Extra Stock, at the "Highland" Show at Aberdeen, 1920.

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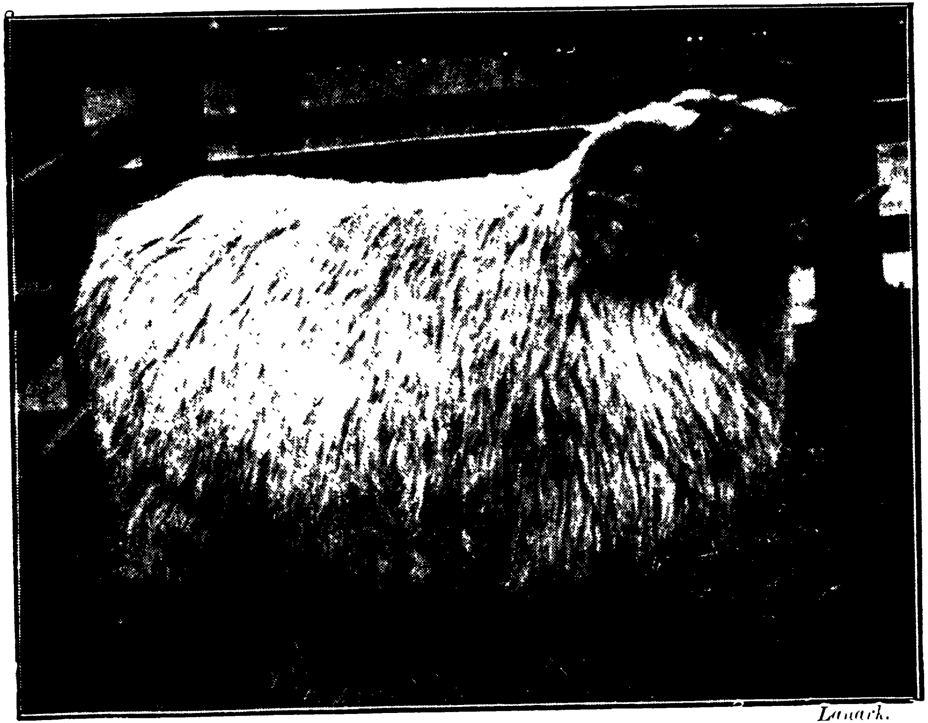
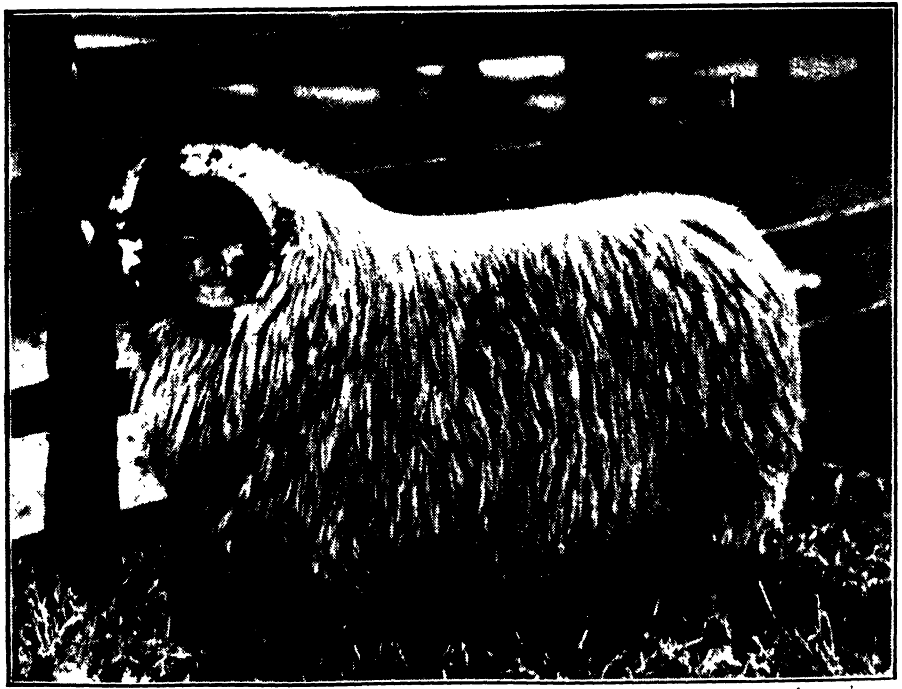


Brown. *Lanark.*

RAM, "THE COMMISSIONER."

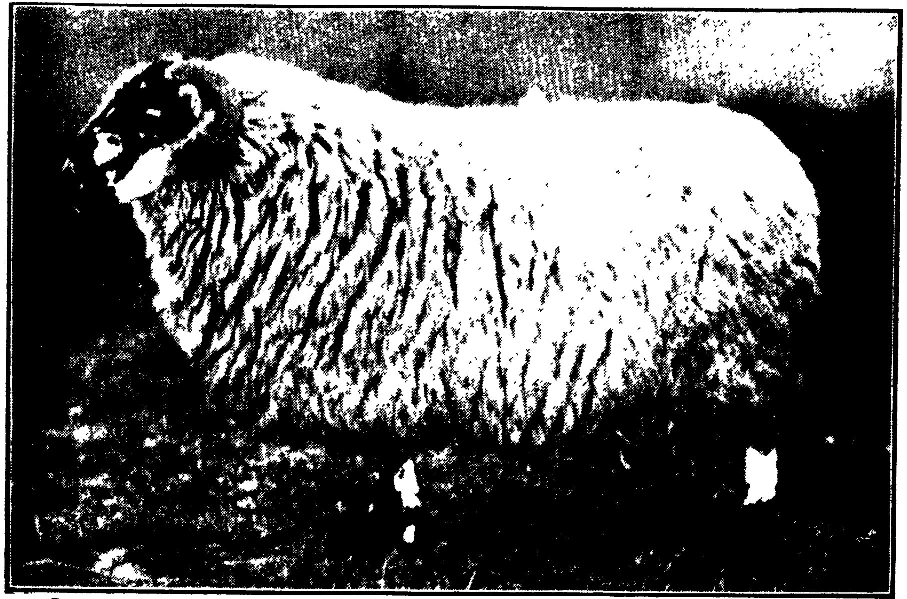
Sold at Lanark, September 1918, at the then record price of £395. The photograph represents him as a shearling when sold at Lanark.



Brown, *Lanark.*

SHEARLING RAM.

Sold at Lanark, in September 1920, for £800



Brown. *Lanark.*

GIMMER, "LADY LOTHIAN."

First in her Class at "Highland and Agricultural Society's Show," Aberdeen, 1920.

there was a sheep early known, at least about Perthshire, as the "Lomond Hill" Sheep, which had some of the characteristics of the Blackfaces. Whatever may be in this, it was from Tweeddale that the sheep began to spread over Scotland. About the time of their introduction to the north, Mr Haldane of Gleneagles, in an appendix to the *Agricultural Survey of Perthshire* says, "There were two kinds, those with blackfaces coming from Tweeddale and those with greyfaces coming from Crawford Moor." But the greyfaces may have been the crosses to which the reference has already been made.

The year 1745 may be taken as the date when the Blackfaces began to spread over the northern hills, as their introduction was one of the immediate results of the failure of the Rebellion of that year, and of the changed social and economic conditions it brought to Scotland. Their introduction raised at least two great controversies, one going on to this day and the other only occasionally coming into prominence. The first was the question of Sheep versus Man, and on this it may be sufficient to say that although sheep had a tendency to displace men, yet if one is to judge from contemporary opinion this was not a necessary result, but was due partly to the perseverance or obstinacy with which the small tenants insisted on adhering to their ancient customs, and partly to the haste with which the proprietors insisted on adopting the new customs. It was asserted by many that with a proper adjustment and understanding between parties all the sheep that were put on the land up to 1800 need not have interfered with the cattle stocks, as the sheep simply consumed what the cattle could not touch.

The other controversy was whether it would not have been better to have improved the sheep then on the land, rather than introduce a new breed. A writer in 1807 says of these native sheep, "These sheep were fine woolled, white faced, smaller and handsomer than the 'Broaked' sheep, but they were very badly managed and spoiled too much by inbreeding. Had they been attended to, they might have become valuable stock having much finer bodies than the redoubtable South Downs." But Blackfaces were at hand, a more profitable and superior breed. There was no time for improvements on the old stock, and thus there was left an opening a century later for discussion and investigation on crossing for wool.

Blackfaces were first taken to Perthshire and Dumbartonshire between 1750 and 1760, and from there they gradually spread over the Highlands. In 1800 it was estimated that there were 22,000 in Perthshire. As has been indicated, the introduction was not made without trouble. Sir George Mackenzie states in his *Survey of Ross and Cromarty* that Sir George Lockhart Ross of Balnagowan, introduced them from Perth to Ross in 1763, and waged a strenuous fight against local prejudices up to 1781, when he let his land to a Mr Geddes from Tummel Bridge. Other tenants followed, but it was only after the failure of a rising against sheep in

1792, when 10,000 were driven off the land into Inverness, that matters settled down and the keeping of Blackface Sheep became an accepted part of the agricultural system of the Highlands.

General Characteristics of the Breed.—The principal characteristics of the breed are its active and vigorous constitution and its ability to live and thrive on land that would not support other sheep. Comparing it with the Cheviots it was said, "The properties of the Blackface Breed are valuable and numerous. Naturally possessed of a more hardy, vigorous and active constitution, and being less affected by the changes and inclemencies of the season, it is satisfied with coarser pasture, is more easily fed or fattened than the Cheviot Breed and, excepting the Braxy, is not so much subject to disease, and only in the wool is there superiority on the part of Cheviots." By another it is said, "These sheep are fed as God Almighty feeds the fowls of the air and the fish of the seas, upon what they can pick up for themselves of Nature's bounty without the labour and assistance of man." To-day, notwithstanding the vast improvements which have been made in the breed, these characteristics have been maintained and there is still no British sheep which requires so little attention from man, or which can take so great care of itself in all weathers. At lambing time especially, they require less attention than any other breed, and the lambs, owing to their well covered condition at birth, are up and about immediately, while the ewes are exceptionally good mothers.

Development of the Breed.—At the beginning of last century the Blackface Sheep was of a scraggy and ill-kept appearance, but of fair size, although slightly smaller than what rules to-day. The wool was from four to five inches long, and of a coarse character in which there was a much greater tendency to discoloration than now exists. All the sheep of the country were then undergoing improvements, and in the south of Scotland, the Border Leicesters were being developed along with the Cheviots. It was an age when the ferment of improvement in all things agricultural was exceedingly active. One of the earliest pioneers in the improvement of the Blackfaces was Mr Dun of Kirkton, Campsie. He was accidentally killed, and most of his sheep passed to the Foyers of Knowehead, who up to about 1885 through succeeding generations carried on the work. Other early improvers were Mr M'Kersie of Glenbuck, Mr Milligan, Kirkhope (breeder of Kirkhope), the Archibalds, Overshields, who have continued almost to this day with a long line of successful sheep. Mr Fleming, Low Ploughland, of Avon Duke fame, Mr Howatson, Glenbuck, breeder of Seventy-two and many other famous sheep, Mr Craig, Craigdarroch, and Mr Greenshields, West Town. Up to the present day the work of improvement has been carried on by many well-known breeders, who have constantly kept in view the desirability of maintaining the constitution of the sheep unimpaired while adding to its beauty and general usefulness. Size, quality of wool and early maturity have been the additional aims of breeders, and whenever there has been a tendency to depart from this, as when the short, strong-woolled sheep, for some years fashionable in the showyard, appeared to threaten the utility of the breed, buyers have shown their preference and thus effectively checked any such tendency. Within the past eight or ten years the breeding of larger sheep has been encouraged, while within a more recent period the wool has become sounder and softer. The earlier sheep exhibited a touch of brown in the faces, but this was not approved of, and the colour desired has varied between jet black and clearly defined black and white patches ("Broaked") and this latter is now the favourite. In the later improvements of the sheep, one of the means adopted was that of inwintering the ram lambs. At the Highland and Agricultural Show of 1867, Mr Greenshields, West Town, obtained 1st, 2nd and 3rd prizes for shearlings, beating the Foyers, who were, previous to that, almost unbeatable. The reasons for this victory were stated to be that the Foyers sheep had a touch of the undesirable brown in their faces, and that Mr Greenshields had helped nature by inwintering the sheep, being the first of the breeders to do this. From that time onward the practice grew and in the 90's almost all the first-class shearlings sold at the sales had been inwintered and early clipped. Much has been said and written regarding the merits and demerits of inwintering, combined with early clipping. About 1900, a certain reaction against inwintering and early clipping set in and the outwintered or at least the late clipped sheep is being looked upon with more favour than at one time seemed likely, and has secured for itself a place in shows and elsewhere. Each form of treatment no doubt has its uses, but if one were to put the matter broadly, it might be said that any treatment which is contrary to the natural habits of an animal must be carried on with greater care and judgment than one which follows these natural habits, otherwise there is the danger that while improvement may be effected in one direction, the inherited constitution may be undermined. Luxury is hostile to production in man or beast.

Early Maturity and Weight.—Owing partly to the older methods of the pastoral farmer, it had come to be a belief that the Blackface could not be at its best until it attained the age of three to five years. Compared with other sheep, this does not appear to have been actually the case; relative to other sheep, there seems always to have been a fairly early maturity, though this was hidden by the fact that it paid the hillman to keep the sheep on a mixed farm for a lengthened period, as, for one reason, it prevented the need for buying in wethers with the possible losses from acclimatising them. In 1802–3 at Edgerston, Roxburgh, an experiment was tried with three wether hoggs of each of Leicesters, South Downs, Cheviots and Blackfaces (called in the report, Forrester sheep). The sheep were purchased in November 1802, and weighed. They were kept for one year, fed on the same food, and given the same chance of improvement. They were again weighed in 1803 with the following result:—

Sheep.	Weight of Three.		Increase.	Percentage Increase.
	1802.	1803.		
Leicesters	219	401	182	83·10
South Downs	217	398½	181½	83·64
Cheviots	182	346½	164½	90·94
Forrester	199	376	177	88·90

At November 1803, the best conditioned sheep of each breed was killed, and the result was as follows:—

Sheep.	Live Weight.	Carcase Weight.	Cost Price.	Selling Price.
Leicester . . .	134 lb.	74 lb.	26/-	54/11
South Down . .	134 lb.	74 lb. 3 oz.	20/-	56/3½
Cheviot . . .	117 lb.	64 lb. 11 oz.	15/-	45/6½
Forrester . . .	135 lb.	71 lb. 7 oz.	13/-	48/8½

From this it will be seen that in comparison with other sheep it kept its own in the way of early improvement, and the conclusion of the experiments was that the Blackface was the most profitable sheep. It was objected to the experiment at the time that the numbers tested were unsatisfactory, and that the food ought to have been measured to each breed, as the Blackface, being so active and voracious, would eat more than their proper share of the food.

In ordinary circumstances Blackface wether lambs direct from their mothers on the hill will average 21 to 28 lb., those fattened for a little longer about 36 lb., year old wethers about 45 to 50 lb., and the older wethers up to 60 to 70 lb., while ewes fattened will scale about 70 lb.

The quality of the mutton is also about the best on the market, the lambs and hoggs especially bringing good prices, and usually touching the top quotations of the market, and, so far as Scotch sheep are concerned, being equalled only by the mutton of the Border Leicester x Blackface Lamb and Hoggetts.

Wool.—This is probably one of the few weaknesses of the Blackface sheep. Bowman, in *The Structure of Wool Fibre*, 1908, says: "The wool is of a medium length, and the fleece, when washed, weighs about 3 to 4 lb., and is never heavy on the body. The character of the wool also is such that it can be used only for the coarser class of yarns, such as those for the manufacture of carpets. The most serious defect, however, is the frequent occurrence of 'Kemps' in the wool." Much attention has been given to the wool, more especially within the past few years, and the opinion appears to be that an improvement is taking place, with the result of largely removing the "Kemps," and also of producing a softer quality. The weight per fleece mentioned above is probably an underestimate at this date and more accurate figures would be up to 5 lb. for good ewe stocks, and up to 7 lb. for wethers; from 4 to 5 lb., however, may be taken as the average clip of a mixed stock, but in the less exposed and especially in southern districts this is considerably exceeded. The average price for the ten pre-war years, as shown in the tables given in the *Highland and Agricultural Society's Transactions*, was 13s. 11d. to 15s. per stone of 24 lb.

Prices.—The prices of the sheep vary with the seasons and the demand. Three-year-old wedders from the hill, on some occasions, have sold to £6 and over during the past years, but this is exceptional. The older ewes command a good price for use for crossing with Border Leicester and other rams, but it is from a consideration of the prices obtained for rams that the best indication can be obtained of the growing importance attached to the breed. These prices are especially notable when it is kept in mind that the trade is almost entirely confined to the British Isles without aid from foreign competition. At Perth Ram Sales in 1900 the highest averages obtained for shearlings and old rams in lots of 10 or over were: Glenbuck (20), £29 15s.; South Brownhill (15), £24 3s. 4d.; Nether Wellwood (14), £13 19s.; Tighnablair (15), £12 8s. 10d.; Boreland and Stonehill (40), £11 9s. In 1921 the five highest averages in lots of 10 or over were:—Woolfords (16), £66; Bogside (16), £28 18s. 9d.; Ascreavie (30), £26 2s. 4d.; Stenhouse (16), £25 7s. 6d.; Urlar (12), £25 1s. 8d., and these figures were considerably lower than those obtained in the previous year. As regards ram lambs, there were in 1920 nearly as many double-figure averages as there were for shearlings in 1900, and the highest average, Drumfork (17), ran to £25 3s. Mr Cadzow, Borland, obtained £800 twice for a shearling in 1920, and Mr Hamilton, Cumberhead, £400 for a lamb.

Crossing.—In addition to the breeding of the pure-bred Blackface, a very large business is done all over Scotland and England in the production of the Greyface, the cross between the Border Leicester and the Blackface, and this is being carried even further by breeding from the Greyface. The Greyface quickly reaches a large size, and the mutton is equal to the best in the market. In Yorkshire, Blackfaces are largely crossed with Wensleydale rams, but this produces a slower growing cross. Crossing South Down with Blackface has been advocated as a method of improving the wool of the Blackfaces, but this cross appears to produce a smaller sheep than either parent breed. The Leicester-Blackface cross produces a good early-maturing sheep, the average proportion of weight at twenty-one months to weight at nine months exceeding the proportion in the case of either parent breed. The importance of the Blackface in crossing when suitably mated is of two kinds: the cross tends to the size of the larger parent, or even exceeds it while the mutton retains very much of the quality of the Blackface, and in the case of the Border Leicester, changes the mutton of that breed from what was at one time called "Coalheaver's Food," to a mutton enjoyed and sought after by the epicure.

Exportation.—In Ireland very considerable progress has been made with Blackfaces. Mr Barton brought over his £250 "St Columba," and Mr Pilkington, Colonel Lowry, and others have done much to create interest in the breed in the North of Ireland, and numbers are taken there annually. Now and again some sheep are sent abroad, and inquiries have recently been received for sheep for the States, Argentine and Japan, but it cannot be said that export flourishes. This is a matter for foreign breeders to consider, and the breeders of this country to push, because, from its constitution and activities, there must be many places where the Blackface would prove highly profitable.

THE VALUE OF FISH MEAL AS A FEEDING-STUFF.

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AND
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THE results of experimental work at this Institute in connection with the mineral requirements of animals showed that the large amount of bone-forming material in fish meal makes it suitable for mixing with grains and certain other commonly used feeding-stuffs which are deficient in this essential. There are, however, among practical feeders wide differences of opinion as to the value of fish meal, and also as to whether or not fish meal taints the animal products. In view of the fact that in a normal fishing season there is sufficient raw material to make 40,000 to 50,000 tons of this meal, which consists almost entirely of flesh-forming and bone-forming materials, it seemed desirable to have more information as to its value, and as to whether or not its use causes a taint. An investigation, including a number of feeding tests, was therefore undertaken. Some results which seem of practical interest are stated here.

Introduction of Fish Meal for Feeding. — In 1892 the Norwegian Government carried out feeding and other experiments to determine whether fish residues made into a meal could be utilised as a feeding-stuff for animals. The successful results of these feeding tests led to the use of fish meal on the continent on a large scale. In this country there was no serious attempt to utilise fish residues, except as manure, until as late as 1905, and then it was the demand from the continent that caused a feeding meal to be made. When it was recognised that there was an export market for all that could be produced, the manufacture of fish meal began to take the place of the manufacture of fish guano at the existing factories at Hull, Grimsby and Aberdeen. Other factories were subsequently erected, and, by 1913, the material was being exported, chiefly to Germany, to the extent of 30,000 tons per annum. It is worthy of note, as an indication of the value set on this material by Continental stock feeders, that in 1914, when maize could be landed at Aberdeen at £6 a ton, Germany was buying fish meal at the same port at £10 a ton and paying the cost of transport.

Very little fish meal was used in this country until about 1916, when the scarcity of imported feeding-stuffs directed the attention of stock feeders to this home-produced material. Since then home consumption has steadily increased.

Method of Manufacture and Composition.—Fish meal is a general name often given to any meal made from fish residues. The term, therefore, covers meals of different composition and different quality. There are, however, two distinct meals—(1) "White fish meal," which is supposed to be made solely from flesh and bones of white fish; and (2) "herring meal," made from herring residue.

White Fish Meal.—This is made from these parts of white fish which are discarded for human food. The fish are gutted at sea. The livers are packed in barrels and the entrails are thrown overboard. Neither of these, therefore, appear in the meal, with the exception of occasional small parts of the liver. At the port the fish are filleted. The heads and bones with a good deal of attached flesh are removed, and it is from these that the meal is made.

At the factory the material is put into a cylinder surrounded by a steam-jacket with the steam at about 280° F., a temperature well above boiling-point. The bones and flesh are disintegrated by the heat and the action of rotating iron mixers. The water of the tissues is converted to vapour and drawn off by an exhaust fan. After about ten hours treatment the stuff is reduced to a fairly dry meal, which is taken out and spread out to cool.

This completed product is a light yellowish brown meal with a characteristic but not unpleasant odour. The following table gives an indication of its composition:—

	Per Cent.
Protein (flesh-forming material)	55–60
Phosphate of lime (bone-forming material)	18–25
Other minerals (including salt)	3–5
Oil	2–5
Carbohydrates, fibre, etc.	1–3
Water	10–14

Herring Meal or Herring Guano.—Herring contains as much as 10 to 20 per cent. of fat or oil. The first process in the manufacture of the meal is to get rid of the bulk of the oil, either by hydraulic pressure or by benzene extraction. The remaining material is then treated as described above.

Unlike white fish meal, the raw material from which herring meal is made, is not of uniform character. The herring are gutted on shore. The residue, therefore, may include the gut with its contents. The other material varies according to the method of preserving the herring. That from salted herring may contain a large amount of salt (crude sodium chloride). Herring meal, therefore, varies in character and composition. The two most variable constituents are oil and salt, both of which are regarded as objectionable if present in excess. The oil is believed to give rise to the marked fishy taint, and the salt to be injurious to the health of the animal.

Herring meal is darker in colour than white fish meal. It varies from a dirty yellow to a dark brown colour. There is a strong fishy odour that clings to the hands and clothes. Its composition, as shown by chemical analyses, is somewhat similar to white fish meal, but the percentages of oil and salt (sodium chloride) are much more variable. This material is largely used as a soil fertiliser. But it is also sold as a feeding-stuff.

Other Meals.—There are other meals which seem to be made from a mixture of whatever fish and fish-offal are available. Sometimes whole fish, unsaleable either because they are unwholesome or on account of a glut in the market, are used. The composition and quality of these meals of course vary widely.

Does Fish Meal produce a Taint?—On account of its high content of protein and phosphate of lime, fish meal is a valuable food for growing animals, and for animals such as cows and hens that are producing the natural foods required for growth. But milk, eggs and the flesh of young animals are the chief animal products used for human consumption, so that if these are tainted by feeding fish meal the use of the meal is prohibited in the very cases where it has a special value as a feeding-stuff. The question of the taint is therefore of the first importance.

On this subject widely different views are held. Experiments carried out at the Seale-Hayne Agricultural College in 1914 showed that in the case of pigs, feeding fish meal up to a pound a day caused no taint in the flesh. On the other hand, many bacon curers and pork dealers refuse to purchase pigs that have been fed with fish meal. Like conflicting opinions are expressed by farmers. Some will not use fish meal for feeding, while others, equally intelligent and experienced, are using it in increasing amounts and having no trouble with taint.

In view of these conflicting statements, made undoubtedly in good faith, it looks as if, in some circumstances there is a taint and in others there is no taint. A series of experiments was carried out to get at the truth of the matter.

The experiments were planned to show to what extent the taint occurs, and also to determine, if possible, what influence in producing the taint is exercised by each of the following factors—(1) the kind of fish meal, (2) the amount used, and (3) in the case of flesh, the time between the last feeding of the meal and the slaughter of the animals.

To make sure that the conclusions reached in these tests would have reference to meals of known composition, white fish meal and meal made from a mixture of white fish and herring residue were obtained direct from the factories, so that the nature of the raw material used was known. A test was also done with commercial "white fish meal," regarding the manufacture of which no inquiries were made.

In the experiments with pigs, Messrs Mellis, Ltd., Bacon Curers, Aberdeen, collaborated in completing the tests by examining and reporting on the quality of the bacon. The expert advice of the staff of the Royal Athenæum Restaurant, Aberdeen, was obtained in connection with the examination of the products for taint and quality.

Tests with White Fish Meal of known Composition.—The meal used was made for the purpose of this experiment at Sandilands Chemical Works, Aberdeen. It was made solely from fresh heads, bones and flesh of white fish. It was finely ground, light yellow in colour, and had no objectionable smell. Its composition was as follows:—

Protein.	Oil.	Mineral Matter.	Water.	Undetermined.
61·1	2·3	25·0	10·3	1·3

Cows.—The milk of cows receiving fish meal up to two lb. per day for two months showed no taste or smell by which it could be distinguished from that of control cows receiving no fish meal.

Poultry.—The meal was fed to pullets and cockerels in the proportion of 1 to 5 of other meals for a period of three months, beginning when they were six weeks old. Neither the flesh of the cockerels nor the eggs of the pullets had any abnormal taste or smell.

Pigs.—A number of pigs were fed on a ration of maize, oats and potatoes with the addition of fish meal to the equivalent of one of fish meal to six of other meals, reckoning four lb. of potatoes as equal to one of meal. The feeding began when the animals were weaned at eight weeks' old and was continued for three months.

The pork had no smell or taint, suggestive of fish meal or otherwise objectionable. Indeed, the culinary expert had "a slight preference" for the flesh of the animals receiving the above ration to that of the control animals receiving less fish meal or none at all.

For the bacon test the animals were drawn off individually at varying intervals before slaughter and fed during the interval on the same ration, but without the fish meal. In the following reports, for clearness, the samples are numbered according to the number of days before killing that no fish meal was fed. A control animal that had never received fish meal is indicated as "x."

> *Bacon Curers' Report.*—"In No. 14 the flesh was too dark and the fat too dull in colour. All the others were good class bacon though the fat was perhaps rather soft. In no case when tested, either raw or cooked, could any special taste or smell be detected that was objectionable or that could give any indication of the food used in feeding the pigs. Arranged in order of merit, the best were Nos. 7, 3, 21 and 0, which were of equal quality. Nos. 28 and 'x' were next best. The worst was No. 14, which on account of the darkness of the flesh and dull colour of the fat could not be regarded as first-class bacon."

> *Culinary Expert's Report.*—"I examined the samples of bacon sent to me recently, uncooked and cooked, but could detect no difference in taste or smell between the different samples. They were all good average bacon. No. 7, after standing cooked for a week, appeared to be darker in colour. I would place the samples in the following order: 0, 14, 3, x, 28, 21 and 7."

Both reports are negative so far as taint is concerned.

Test with Fish Meal made from a Mixture of Materials.—The raw material from which this meal was made consisted for the most part of white fish residue. There was mixed with it a quantity of "kippers"—herring residue. The meal was light yellow in colour, and had only a slightly stronger odour than the white fish meal used in the foregoing tests. Chemical analyses showed it to have the following composition:—

Protein.	Oil.	Mineral Matter.	Water.	Undetermined.
62·2	6·4	13·6	14·6	3·2

Experiments essentially the same as those described above were conducted. The results can be briefly stated.

Cows and Poultry.—No fishy taste or smell was detected in the products.

Pigs.—In the following reports the numbers indicate the number of days before killing that no herring meal was fed. Two (0a and 0b) had fish meal to the day of slaughter, two (7a and 7b) to within seven days, and two (14a and 14b) to within fourteen days. Otherwise the ration was identical. It had one part fish meal to six of other meals.

> *Pork: Culinary Expert's Report.*—"No. 0a a very fine sample, tastes like the breast of a chicken, sweet smell. Nos. 7a and 14a, appearance good, but not so sweet flavoured. No. 7b, equal in appearance to Nos. 7a and 14a, but flesh rather dry and hard. No. 14b, appearance all right, flesh dry and tough. No. 0b, of good appearance, but flesh hard and smells strongly."

Bacon: Curer's Report.—"In all the samples the fat was too oily and too dull and dark in colour. Nos. 14a and 0a were fishy tasted. In Nos. 0b, 7a and 7b and 14b no objectionable taste could be detected."

The results of these tests show that the addition of herring residue to the material from which fish meal is made is liable to cause a taint in the flesh.

Tests with Commercial Fish Meal.—This experiment was carried out at the Lancashire County Council Farm by Mr Green.

Fish meal from different makers was used in the course of the experiment. It was all sold as "white fish meal," but no inquiry was made as to the nature of the materials used in its manufacture.

Six pigs from eight weeks old were given a mixture of sharps, maize, palm kernel cake and fish meal. The fish meal constituted one-eighth of the total meal ration. Until eight months old they were allowed to run on poor grass land. During the last two months they were confined. The pigs were killed at varying intervals after the fish meal had been eliminated from the ration.

The products were tested by Mr. Green and his co-workers.

Pork.—No taint whatever was found, even in the pigs fed with fish meal to the day of slaughter.

Bacon.—In the samples from pigs fed with fish meal to within fourteen days of killing there was a distinct fishy taint and the fat was yellowish in colour. In the samples from the animals which had received no fish meal for more than fourteen days before killing, the fat was snow white and the bacon was mild and agreeable, without any trace of taint.

Results of Experiments on Taint.—The results of these trials show that white fish meal, if made entirely from fresh tissues of white fish, can be used up to the full amount that it is economical or beneficial to use fish meal, without producing any taint that interferes with the palatability or lessens the market value of the animal product.

The results of the experiments on pigs with meal made from a mixture of white fish residue and herring residue, and with the commercial meal, justify the statement of the Bacon Curers that a taint is sometimes produced in the bacon. Even with a commercial meal of the grade used however, the taint can be avoided if no fish meal is fed during the last three or four weeks of the fattening period.

So far as a taint is concerned the quantity of fish meal fed need hardly be considered. In all these experiments the amount of fish meal fed was in excess of the requirements of the animal. In none of the tests did the amount of fish meal affect the results to anything like the same extent as the kind of meal, and the length of time between feeding the meal and killing the animal.

The practical conclusions seem to be (1) that white fish meal can be used without fear of taint for any purpose except the production of bacon, and that in that case it can be used with safety up to within three or four weeks of killing, and (2) that certain kinds of other fish meals could be used for many purposes by a careful feeder, but further investigations would be required to determine the quality that could be used with safety.

It would be of value to know with certainty, why some meals like the white fish meal used, cause no taint, and some others, such as those made from material containing herring residue, give a distinct taint. On theoretical grounds the constituent that would be expected to cause the taint and the discolouration of the fat is the oil, because fat or oil can be absorbed from the intestines and deposited in the body in the same form in which it was in the food. The subject is at present being investigated and will be dealt with in a further communication.

Assimilation of Fish Meal by Growing Animals.—The value of a feeding stuff depends not upon the percentage of the nutritive constituents present, but upon the extent to which these can be digested and absorbed by the alimentary canal and utilised by the living tissues. The two chief constituents of fish meal are the protein and the mineral matter, which together form about three-fourths of it. Experiments were made to test the value of these to the growing animal.

Digestibility of Protein.—This was tested with a young pig which, during the experiment was given a constant ration. For five days in the middle of the period, 100 grams of fish meal was added to the ration. The amount of undigested protein (Nit. x 6·25) in the faeces was determined daily. The following table shows the results :—

DIGESTIBILITY OF FISH MEAL PROTEIN.

	Intake in Food.	Amount in Faeces.	Amount Digested and Absorbed.
	Grams.	Grams.	Grams.
Ration only . . .	136	29	107
Ration + 100 grams fish meal . . .	197 (136 + 61 of fish meal)	33	164
Ration only . . .	136	28	108

The addition of 61 grams of fish meal protein caused a rise of 4 grams of protein in the faeces, so that 57 grams must have been digested and absorbed. The pig can, therefore, utilise over 90 per cent. of the protein.

Utilisation of Lime and Phosphorus.—These are the chief constituents of bones and are the two minerals required in greatest amounts by the growing body. In some forms, however, only a small percentage of these can be digested and absorbed. It has also been found that in any ration the amount of either that can be utilised depends upon the amount of the other that is present. In fish meal the ratio of calcium to phosphorus is about the same as is required for growth, and it might be expected that the percentage utilisation would be high. That this is so is shown by the results of the experiment recorded below.

A growing pig was given a constant ration and for a five day period in the middle of the experiment there was added to the food 100 grams of fish meal per day. The amounts of calcium and of phosphorus excreted in both urine and faeces were determined.

UTILISATION OF LIME AND PHOSPHORUS.

	Lime (as CaO).		Phosphorus (as P_2O_5).	
	Intake.	Retained	Intake.	Retained.
	Grams.	Grams.	Grams.	Grams.
Ration only . .	0·65	0·13	6·9	3·7
Ration + 100 grams fish meal	12·20	4·70	17·4	8·4
Ration only . . .	0·65	nil.	6·9	3·4

Of the amounts of these two essential minerals given in the fish meal more than a third was utilised by the animal and the amounts utilised were just about what the animal would be expected to require.

Feeding Tests.—The value of fish meal for growing animals has been demonstrated by several carefully conducted feeding experiments. At the Experimental Farm of the University of Leeds it was shown that the substitution of fish meal for an equal weight of sharps to the extent of a ninth of the ration, increased the gain per day from 1·35 lb. to 1·54 lb. Somewhat similar results were obtained at the Experimental Farm of the West of Scotland College of Agriculture, and at Seale-Hayne Agricultural College.

An interesting feeding test carried out by Mr Frank Pick at Mr J. Q. Rowett's Model Stock Farm, Ely Place, Frant, Sussex, shows the excellent results that may be got in pigs with fish meal. Four pigs were fed for eight weeks on a mixture of equal parts of maize meal, middlings and oatmeal, with the addition of potatoes and on an average 6 oz. of fish meal each per day. The average gains in weight are shown by the following figures :—

Weight, 2/11/21.	Weight, 28/12/21.	Gain.
65·5 lb.	141·25 lb.	75·75 lb.

The amounts fed per pig per day were 2·3 lb. meal, 2 lb. potatoes and ·44 lb. fish meal, and the average gain in weight per day was 1·35 lb. Taking 4 lb. of potatoes as equivalent to 1 lb. of meal there was a gain of a pound in weight for every 3·24 lb. of meal eaten.

In our feeding experiments with fattening pigs beginning about 80 lb. weight and finishing off about 170, we got a gain of 1¾ lb. to 2 lb. per day. The rate of gain per unit of food eaten varied with the age of the animal, being greatest in the young and decreasing with age. Over the whole fattening period when the weight increased from 80 to 170 lb. the average amount of food eaten in meal equivalent per pound of gain was about 3·6 lb.

Many other tests have been carried out at various centres. In some of these greater gains per day and per unit of food eaten have been obtained. While there is divergence of opinion on some points, there seems to be unanimity on the question of the value of adding fish meal to a ration of grains and grain offal.

Factors in the Value of Fish Meal.—*Vitamins.*—It has been stated that the chief virtue of fish meal lies in a vitamin "fat soluble A" present in the oil, and that extraordinary results can be obtained with fish meal containing large quantities of oil. Experiments carried out here, however, have shown that the pig is little susceptible to deficiency of this vitamin and that very small amounts, such as are likely to be present in any ordinary ration, especially if it contains any green food or milk, are sufficient.

To test whether the addition to a ration of large amounts of this vitamin would show any marked effects, an experiment was conducted with ordinary white fish meal which had less than 3 per cent. of oil and the same meal with cod-liver oil, a substance very rich in the vitamin, added to it. Two pens of three pigs each were put on the following ration:—

	Proportion.
Maize Meal	100
Locust Bean Meal . . .	100
Potatoes	200
White Fish Meal . . .	50

To the food of one group was added 30 c.c. rising to 90 c.c. of cod-liver oil per day, and to the other to balance the energy value of the cod-liver oil an equal amount of linseed oil which contains little or no vitamin.

The following results show that the cod-liver oil, rich in "fat soluble A," had no more effect in increasing the weight than linseed oil, poor in it.

AVERAGE WEIGHTS IN LB.

	15/6/21.	23/9/21.	Gain.
Linseed Oil . . .	34·3	112·8	78·5
Cod-liver Oil . .	36·3	112·4	76·1

The animals were in very poor condition at the beginning of the experiment and made only trifling gains for the first few weeks. If the fish meal with the high amount of oil has any special virtue for health and growth it is in poor conditioned animals such as these, that its effect would be most likely to be shown.

In another experiment with feeding-stuffs of the same nature to one group fish meal was given with the addition of cod-liver oil and to a control group on a ration otherwise identical the fuel value of the cod-liver oil was balanced with oatmeal: the results were:—

AVERAGE WEIGHTS IN LB.

	3/9/20.	1/11/20.	Gain.
Cod-liver Oil . . .	89·1	193·6	104·5
Oatmeal	86·5	192·9	106·4

With any ordinary ration, meal with 3 per cent. of oil is likely to be as valuable, so far as vitamin is concerned, as meal with 10 per cent.

Mineral Matter.—Experiments carried out here by Mr A. D. Husband, A.I.C., have shown that a pig of three to four months old can absorb and retain as much as 5 grams of lime (CaO) per day. This mineral is required in the food to the extent of one to two per cent of the increase in weight, and growth is limited if the supply in the food is not sufficient. Grains are deficient in lime. Sharps contain only 0·08 per cent. and maize less than 0·02 per cent. A pig putting on 2 lb. per day would require to eat over 20 lb. per day of a mixture of equal parts of these to get sufficient lime, whereas a quarter of a pound of fish meal would yield more than sufficient. It is not to be wondered at, therefore, that the addition of fish meal to a ration of grains and grain offal leads to increased gains in weight.

The results of experiments carried out in connection with mineral requirement led us to believe that the undoubted beneficial effects of fish meal in growth were largely dependent on the minerals present. To test this an experiment was carried out comparing fish meal with blood albumin (almost pure protein) to which mineral matter similar to that in fish meal had been added. It was found that the ration with blood albumin plus minerals gave as good results as fish meal, but that with blood albumin alone, although for the first fortnight the gains were as good as with fish meal, afterwards, growth slowed down and was no better than with a purely grain ration.

Protein.—The value of this constituent is so well recognised that it need not be discussed. It has already been shown that it can be digested and utilised by the pig to the extent of over 90 per cent.

Practical Use of Fish Meal.—*The kind of Animals.*—Fish meal is a special kind of food in so far as it consists almost entirely of constructive material required for growth. It is of special value therefore for growing animals and for full grown animals, such as cows and hens, that are producing the material necessary for the growth of the young. Its value for growing pigs is well known, and experiments at the West of Scotland College of Agriculture have demonstrated its value for calves.

Both milk and eggs consist very largely of protein and mineral matter. Three gallons of milk contain about one pound of protein, three-fourths of an ounce of lime (CaO) and an ounce of phosphorus (P_2O_5) so that a cow giving that amount of milk per day, loses these quantities of essential substances that must be made good in the ration, unless it draws on its tissues and bones for them.

Egg, like fish meal itself, consists almost entirely of protein, minerals and fat. For milk cows and poultry therefore, fish meal seems a most suitable food and it is not difficult to understand why good results are obtained in feeding it to these animals.

The Amounts to Feed.—No fixed rule can be stated in terms of a fraction of a ration, as a guide to the proper amounts to give. That depends on the nature of the other food-stuffs being fed and what the animal is producing. For a growing animal producing new tissue the proportion of protein to the other energy yielding constituents of the ration (*i.e.* nutritive ratio) should be about 1 to 4 or 5, for young animals, and 1 to 6 or 7 for animals reaching maturity. A mixture of common meals and grains like sharps, barley and maize has a protein ratio of about 1 to 7 or 8. For such a mixture, only a small amount of fish meal is required to yield the requisite proportion of protein. A ration of the following proportions would be about right to give a ratio of 1 to 5.

	Proportion.
Sharps	100
Maize	100
Barley	100
Fish Meal	15

With food-stuffs containing less protein, such as maize and potatoes, more fish meal would be required. A ration of :—

	Proportion.
Maize	100
Potatoes	300
Fish Meal	27

would give a ratio of about 1 to 5.

The proportion of protein required decreases as the animal approaches maturity, so that the proportion of fish meal in the ration should be steadily reduced until, when the animal is chiefly laying on fat it is no longer required and is not economical to feed since the cheaper starchy foods are better fat formers than the more expensive protein foods.

For cows and poultry the amount that should be fed depends on the amount of milk and the quantity of eggs produced, and would require to be separately calculated for each case. In general, larger amounts could be fed to them than to growing animals.

For full grown animals which do not require large quantities of protein and mineral matter, large amounts of fish meal could not be used with profit. If it is fed to them it should be given in very small amounts.

With regard to meeting the requirements for mineral matter, fish meal is so rich in this, that if sufficient be given to yield the necessary amount of protein, there is likely to be more than sufficient mineral matter present.

Conclusions.—(1) White fish meal, if made entirely from the heads, bones and flesh of white fish, produces no taint in pork, bacon, milk, eggs or chicken flesh.

(2) Other fish meals may taint bacon. This can be avoided if no fish meal be fed during an interval of four weeks before killing.

(3) Fish meal is an excellent supplement to grains, grain offal and potatoes because it provides protein and mineral matter, in both of which these foodstuffs are deficient.

(4) Fish meal is of special value for growing animals, milk-cows and poultry.

THE FEEDING OF HENS.

DAN. W. STEUART, B.SC.

THE ration of an animal can be defective in any of the following respects:—

1. Total food value.
2. Quantity and quality of the proteid.
3. Bulkiness or amount of indigestible ballast.
4. Mineral content.
5. Vitamine content.

Experiences have been accumulating on the subject of hen feeding and it is interesting to survey the results keeping the above points in view.

1. **Total Food Value.**—Bartlett (1911) concluded from his tests that, on the whole, fowls digest their food ingredients about as well as other farm animals, except perhaps in the case of fibre. Maize, maize meal and cracked maize gave about equal results, but rolled oats were digested much better than whole oats. Hari, Szalagyi and Kriwuscha (1917-18) in metabolism experiments with hens, ducks and geese got results pretty similar to those which have been obtained with other animals.

In these circumstances it will probably be most convenient when computing rations for fowls, to make use ot the unit values obtained from feeding cows, viz.:—1 of barley = ·6 of flesh meal or linseed; ·65 of dried blood; ·7 of hempseed; ·8 of dried yeast; ·95 of maize or gluten feed; 1 of fish meal, middlings, peas or wheat; 1·2 of oats or bran; 1·3 of buckwheat and so on.

The amount of food which an animal requires for maintenance is roughly proportional to the total extent of the surface of its body. An omnivorous animal requires about 1 lb. of barley equivalent per square metre of body surface (*c.f.* Lucas-Mallèvre, 1920). Thus a grown hen of 4·4 lb. live weight and ·166 square metres of surface should need about 2·7 oz. of barley equivalent per day to maintain its weight. If we now assume that egg production in the hen will be just as efficient as milk production in the cow, we can figure from the average composition of a 2 oz. egg (Hansson 1918) that a hen will need about 1·45 oz. of barley equivalent, in addition to the maintenance ration, to produce each standard egg.

In Danish egg-laying tests the birds were weighed regularly up to 3½ years old, the weights of foods supplied and of eggs produced being also recorded. From the data there obtained, one judges that the figures shown above are in fair agreement with practical results. Thus the following figures should be approximately correct:—

Liveweight of hen, lb.	Number of 2 oz. eggs laid per annum.			
	0	100	200	300
	Total barley equivalent required daily per bird—oz.			
3·3	2·3	2·7	3·1	3·5
4·4	2·7	3·1	3·5	3·9
5·5	3·1	3·5	3·9	4·3
6·6	3·5	3·9	4·3	4·7

In the Danish tests some 100 eggs were laid and the birds received from 3·1 to 3·6 oz. of barley equivalent daily (3·2 to 4·4 oz. of food). This includes the roots supplied during the winter, but not the material picked up from the grass run. In the English tests 3·6 to 3·8 oz. of barley equivalent (4 oz. food) were supplied to birds laying 150 to 200 standard eggs. This includes no greenstuff and no weights of the hens are recorded. In a recent American test where all the food was weighed, hens of 3·5 lb. got 2·8 oz. barley equivalent (2·8 oz. food) and laid about 100 eggs.

With regard now to the rearing of chicks, the following figures indicate the amount of food required to produce a chick of a given weight, when fed on a grass run:—

Live weight lb.	Food eaten lb.	Food eaten to produce each 1 lb. weight.
1	3	3·0
2	7	3·5
3	12	4·0
4	18	4·5
5	26	5·2

The figures obtained vary with the efficiency of the ration and the vigour of the chicks. To rear a chick to six months old, in the

Danish experiments, the following amounts of food were required, the chicks being fed according to their eagerness for food:—

	Buff Orpingtons 1910.	Buff Orpingtons 1911.	Brown Leghorns 1911.
Food eaten—lb.	20·5	26.3	26·8
Initial weight—lb. . .	·08	·08	·09
Weight six months later—lb.	3·83	5·14	4·85
Lb. food per 1 lb. growth .	5·4	5·2	5·6
Final ration—oz. per day .	2·9	4·4	4·2

In Paynter's Farne Islands experiment, table birds weighing 5·3 lb. were produced in 20 weeks with a consumption of 26·6 lb. of food, or 5·1 lb. food per 1 lb. of growth, and during the last month of the test the birds ate 5·1 oz. of food daily. The rate of growth in chicks fed *ad. lib.* evidently depends largely on their capacity to consume food. No animal food was supplied in this test.

2. **The quantity and quality of the proteid.**—As grains and their by-products form the chief food of fowls this point is important. The proteids of seeds have a lower value for growth than animal proteids. A mixture of several seeds will usually give better results than only one kind, but to attain the quickest growth and the most economical results some animal food must usually be consumed in addition.

Osborne and Mendel (1916) found that chicks with half their proteid supplied as maize gluten and half as lactalbumen, grew six times more in the same time than chicks supplied with all their proteid as maize gluten. Buckner and collaborators (1920) concluded that the proteids of rice, oats, barley, hominy and gluten flour are inefficient for promoting normal growth and fail to produce normal sexual development in a young chick. Skim milk in addition to meat scrap did not further enhance the growth and subsequent egg production. Philips, Carr and Kennard (1920) in tests with chicks fed for six months on a basal ration of ground maize, maize products, ash and charcoal, with meat scraps, or soya meal as supplement, got the best results with soya meal: a mixture of soya meal and fish scraps came next best. Previous to this Osborne and Mendel (1917) had shown that soya bean proteid or a mixture of soya bean proteid with maize gluten, could support normal growth in rats. As Johns (1919) has been able to promote practically normal growth in rats with the proteid of coconut or groundnut cake we may perhaps conclude that the proteids of soya, coconut or groundnut press cake are superior to those of other seeds. Unfortunately these foods have the same mineral deficiencies as other seeds. The poor value of maize as a sole food for half grown chickens was shown by Pennington (1918). Chicks weighing about 1·7 lb. gained only 5 per cent. in fourteen days on maize and water, but 30 per cent. in the same time on maize and buttermilk.

With regard now to egg production, a 2 oz. egg contains about ·21 oz. of proteid, and to produce that a hen probably needs about ·32 oz. of digestible proteid in addition to her maintenance allowance. We would expect, then, to have to feed a generous allowance of proteid to laying hens. Philips (1918) experimenting with Plymouth Rock pullets fed on mixed grain with a mash of bran and shorts, got the following results :—

Grain and Mash	61 eggs per year
Grain, Mash and Skim Milk ...	144 „ „
Grain, Mash and Meat Scraps ...	136 „ „

Ahrens (1917) found that for the production of eggs, beef scrap was superior to cotton-seed meal, and more than made up for the extra cost by the extra production. The mortality among the chicks was greater in the cotton-seed pens. Harney (1918) concluded that hens fed with animal food are more profitable than those receiving vegetable food only. Vegetable feed, with a high proteid content, seemed unable to replace entirely the animal feeds. Kempster and Hervey (1918) thought meat scraps and sour milk were the most economical sources of proteid for laying hens. Meat scrap and gluten meal gave good results when meat scraps formed ⅓rd of the protein base; meat scraps and cotton-seed meal gave good results, when meat scraps constituted ¾th of the protein base. This type of experiment has shown that good results are obtained when the proteids of the seeds are supplemented with proteids of animal origin. M'Collum's experiments with growing rats showed that gelatin supplements the proteids of wheat and oats, but not those of peas or maize which can, however, be supplemented by casein. He found, too, that the proteids of potatoes considerably supplement those of seeds, and the proteids of leaves also supplement those of seeds. This is one reason why dried leaf meal of nettles, clover or lucerne makes a useful addition to the mash during winter. To what extent the proteids of roots supplement those of seeds has not been tested. The fact remains, however, that hens fed on mixed grain, on a grass run, supplemented only by roots during winter, will lay a fair number of eggs—about 100 in the Danish tests. To realise fully, however, how one proteid can supplement another, we turn to Osborne and Mendel's experiments using pure proteids (1915). Using zein, one of the proteids of maize, as the sole proteid, the diet cannot even maintain the body weight; a diet containing 4½ per cent. of lactalbumen gave only poor growth; but a ration containing 4½ per cent. of albumen, and 13½ per cent. of zein, permits normal growth in the rat.

3. **Bulkiness or Amount of Indigestible Ballast.**—Hart, Halpin and Steenbock (1920) considered that leg-weakness in chicks reared under laboratory conditions was due to lack of suitable roughage in the ration. It could be prevented by including 10 per cent. of paper in the ration, but by no other known food factor. This confirmed the conclusion of Osborne and Mendel (1918), who considered that leg-weakness was due to the low amount of indigestible ballast in the ration. Under ordinary conditions greenstuff supplies what is required.

4. **Mineral Content of the Ration.**—Kaupp (1918) studied the mineral needs of growing chicks, and the mineral content of chick foods. A growing chick has a steadily increasing requirement of lime, magnesia, phosphate and sulphur. To attain the best growth the food should contain, besides mill products and ground grain, also skim milk or butter milk. Kaupp and Ivey (1920) examined the potential acidity or alkalinity of poultry foods. Grain mixtures are usually acid. Mash mixtures containing digester tankage, meat or bone meal, dried milk or dried blood will be basic. Acid balances can be overcome by feeding such animal feeds, greenstuff, oyster shell or limestone, or by giving milk to drink. Do acid feeds interfere with growth or egg production? When Morgen and Berger (1915) found that rabbits steadily lost weight on a diet of oats, the addition of bi-carbonate of soda or carbonate of lime caused a steady improvement and gain in weight: an addition of common salt or diphosphate of lime was useless. In M'Collum's experiments with rats, all seeds showed a mineral deficiency which could be corrected by an addition of common salt and carbonate of lime. Henry, too, got much better growth in pigs fed on maize when he added lixiviated wood ashes or bone meal to the diet; while Hart (1914) reported an improvement in the lime and phosphate metabolism of pigs fed on grain rations, when these were supplemented by carbonate of lime, bone ash, ground mineral phosphate or leguminous roughage. There is little doubt, then, that leaves, milk or fish meal considerably supplement the minerals of the seeds for growing chicks.

As a 2 oz. egg includes about ·28 oz. of ash, which is principally carbonate of lime with a little phosphate of lime and magnesia, we usually supply laying hens with carbonate of lime in the form of oyster shell or cockle shell. Buckner and Martin (1920) divided white Leghorns into several lots all of which got the same grain and mash ration during six months. Hens receiving no additional lime went on laying till there was a general depletion of lime, magnesia and phosphate in the bones and carcase.. The shells of the eggs gradually got thinner. The average egg production was much higher in the hens receiving oyster shell or limestone in addition. In this connection some experiments of Hart, Steenbock and Hoppert (1920) may have some significance. In experiments with cows and goats, they concluded that there is something in greenstuff which beneficially affects the assimilation of lime by animals, and so affects growth and milk and egg production. Robb (1920) thought this was due to the vitamine C., which is present in greenstuff but is largely destroyed when that material is dried. Fingerling (1911) found also that the phosphates in hay were less useful to young lambs and goats, than those in the original green stuff. We know, too, that the availability of all the nutrients in any roughage is decreased by drying it into hay. It is in a somewhat similar manner that the value of milk to very young animals is adversely affected by cooking (Eichlov, 1912). The more recent experiments of Hart, Steenbock and Hoffert (1921), show that the beneficial effect of greenstuff as compared with dried plant material can be imitated by codliver oil but not by orange juice; so evidently the factor concerned is the Vitamine A.

Delezenne and Fourneau (1918) showed that a chick on hatching has obtained $\frac{4}{5}$ths of the lime necessary for its development and the formation of its skeleton from the egg shell, while $\frac{1}{5}$th of its lime and all its phosphate is derived from the contents of the egg.

Characteristic substances in the yolks of eggs are the phosphorised fats. M'Collum, Halpin and Drescher (1913) fed hens on extracted rice and skim milk powder, a ration almost devoid of fat. The number of eggs laid was about normal, and the phosphorised fats in the eggs very much exceeded the total fat supplied in the food. Fillory fed ducks on a ration devoid of organic phosphorus, but supplied carbonate of lime and precipitated phosphate. The eggs laid were about normal in number, and they contained the usual amount of phosphorised fats and phosphoproteins.

5. **The Vitamine Content of the Ration.**—*Vitamine A.* Hart, Halpin and Steenbock (1917) fed chickens below half normal weight on rations restricted to maize, maize-gluten feed and carbonate of lime, and the chicks were able to make slow growth. On a ration restricted to wheat, wheat-gluten and carbonate of lime life terminated in three months. Though wheat will maintain adults, it will not maintain young chickens. The addition of casein and minerals to the ration did not make it adequate. Butter fat was required. Butter fat, fish liver oils, green leaves, egg yolk, bone marrow, and even the germs of some seeds contain the vitamine A. It is essential for the growth of animals, though in some cases—*e.g.*, pigs, very little suffices. Animals cannot make full use of the lime, etc., in their food if the ration is deficient in this substance.

Vitamine B. Fowls fed on highly milled cereal foods develop nervous disorders and paralysis, and finally die. This is due to the lack of Vitamine B which is present in practically all natural foodstuffs, but in grain is concentrated in the germ or embryo, being present in the bran to a less extent (Chick and Hume, 1917). Vœgtlin, Lake and Myres (1918) found that wheat and maize foods containing little of the outer layers and germ caused the birds to turn ill in three weeks. Weill and Mouriquand (1916) found that pigeons fed on polished rice alone turned ill in three weeks, while on pearl barley the trouble appeared in fifty days. This same polyneuritis of birds is known as beriberi in other animals and it can be entirely prevented by proper feeding. A little yeast or marmite quickly affects a cure in the diseased animals.

Vitamine C. To certain animals, viz.:—Humans, monkeys and guinea pigs this anti-scorbutic substance is necessary; though a monkey apparently needs no more than a little guinea pig

(Harden and Zilva, 1920). Rats, though they seem to thrive better when it is supplied, seem to do well enough without it. This is evidently because they are able to manufacture this substance for themselves (Parsons, 1920). Egg yolks contain vitamines A and B, but apparently none of Vitamine C, yet chicks hatch from them. It is absent in dry seeds, but present in germinated seeds; so possibly it is produced in eggs during incubation. Whether it has to be supplied to growing chicks or not, it is just as well to recollect that the scurvy-preventing vitamine is present in fresh green-stuff and roots.

The colour of egg yolk is greatly influenced by the feeding of the hen. Willstätter's work on the pigments of the green leaf showed these to consist of chlorophyll pigments, 85 per cent., and yellow pigments, 15 per cent. Of the yellow colouring matter about one-third is carotin and two-thirds xanthophyllin. Palmer and Eckles (1914) showed that the natural colour of butter was due to carotin, while the colour of egg yolk on being investigated by Palmer and Kempster (1911) proved to be xanthophyllin. They fed hens on a ration of white maize, white maize bran, bleached flour, skim milk and bone meal, which contain practically no pigment. Chicks were successfully reared on these foods from hatching to maturity. The hens then laid eggs which were practically free from colour and yet hatched well. The chicks had no yellowness of ear-lobes, skin, beak or shanks. The appearance of yellow pigment in the visible skin parts or in egg yolk is regarded merely as a means of excreting it from the body of the hen because the pigment bears no relation to growth, fecundity or reproduction in the fowl. Foods rich in xanthophyll are green-stuff and yellow maize; there is some in red maize, barley, hemp-seed, linseed; but practically none in wheat, oats, cotton-seed, rape seed, meat scraps and blood meal.

Hens, then, are general feeders, and it is advisable to feed a mixed diet in order to avoid a deficiency of one thing or other. The hatchability of eggs and the vigour of the chicks depend to some extent on the proper feeding of the hens. The following is an example of a satisfactory ration:—

	Parts by weight.	Barley equivalent.	Digestible proteid.
Fish meal	1	1·00	·470
Middlings	2	2·00	·214
Ground Oats	1	·83	·076
Ground Maize	1	1·05	·065
Wheat	2	2·00	·186
Oats	2	1·66	·153
Maize	1	1·05	·065
	10	9·6	1·23
	4 oz. :	3·84 oz.	
		1 :	·128

Of such a ration 4 oz. per bird daily, with some green-stuff, grit and shell, should be capable of supporting an egg production of 200 per annum. In many large flocks the egg production may be nearer 100 and in that case half the fish meal might be cut out of the mixture and only 3½ oz. fed.

If pretty much the same amount of food is supplied to hens all the year round, it will be found that they tend to put on weight from the Autumn to the Spring, and lose weight during the period of maximum egg production; the body substance of the hen obviously being requisitioned for egg making. This seems to suggest heavier feeding from March to May when the hens are laying well, and feeding less when the hens are yielding badly in October to January. Whether this could be arranged depends on the capacity of the hen to consume the heavier ration when required to do so, which is doubtful.

Finally, a good hen requires about 3½ lb. of barley equivalent to produce 1 lb. of eggs. If we compare the hen and the cow (*vide* this *Journal*, Oct. 1920, p. 437) as producers of human food, we conclude that the hen does not and never will rival the cow, except perhaps in the conditions where her food consists principally of stuff which would otherwise be lost. The pig as a food producer probably occupies an intermediate position between these two; while the bullock comes last.

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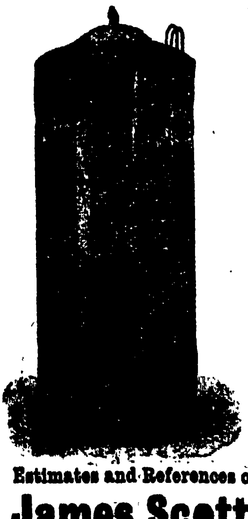

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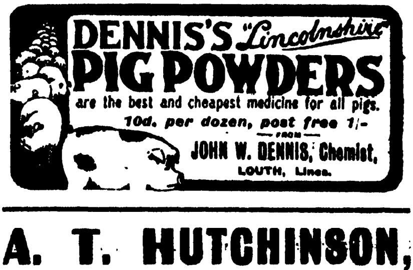

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THE INTERNATIONAL LABOUR CONFERENCE AT GENEVA.

H. M. Conacher.

Note.—The important place given to agriculture at the 1919 Conference of the International Labour Organisation seems to justify an account of the origin and working of the Organisation.

Part XIII. of the Peace Treaty, dealing with Labour, begins with a preamble which should be better known than it is, as recalling men, who are now living in the light of common day, to the sentiments which were felt and expressed in the mood of exaltation and longing for a better world which possessed the multitudes of the governed for a few months after the end of the War. For this reason it is here quoted in full:—

> "Whereas the League of Nations has for its object the establishment of universal peace, and such a peace can be established only if it is based upon social justice;
>
> "And whereas conditions of labour exist involving such injustice, hardship and privation to large numbers of people as to produce unrest so great that the peace and harmony of the world are imperilled; and an improvement of those conditions is urgently required: as, for example, by the regulation of the hours of work, including the establishment of a maximum working day and week, the regulation of the labour supply, the prevention of unemployment, the provision of an adequate living wage, the protection of the worker against sickness, disease and injury arising out of his employment, the protection of children, young persons and women, pro-

vision for old age and injury, protection of the interests of workers when employed in countries other than their own, recognition of the principle of freedom of association, the organisation of vocational and technical education and other measures;

"Whereas also the failure of any nation to adopt humane conditions of labour is an obstacle in the way of other nations which desire to improve the conditions in their own countries;

"THE HIGH CONTRACTING PARTIES, moved by sentiments of justice and humanity as well as by the desire to secure the permanent peace of the world, agree to the following:—"

It is not often that High Contracting Parties use language of this kind, and it breathes a kind of eloquence more native to Latin tongues than English, a language which, however, was used for the American Declaration of Independence. What the High Contracting Parties agreed to was the establishment of a permanent organisation "for the promotion of the objects set forth in the Preamble." The organisation was to consist of the original members of the League of Nations, and membership of the League of Nations was to carry with it membership of the organisation. The Republic of Austria is now a member of both, and the Republic of Germany has been admitted a member of the International Labour Organisation. The United States still stands out of both.

The organisation was to consist of a General Conference of representatives of the members, originally designed to meet every year, and an International Labour Office, which is established at Geneva, in accordance with a provision that it should be established at the seat of the League of Nations as part of the organisation of the League. The Conference was to be composed of four representatives of each of the members, "of whom two shall be Government delegates, and the two others delegates representing respectively the employers and work-people of each of the members."

The International Labour Office is under the control of a governing body of twenty-four persons, including twelve representing the governments, and six elected from time to time by the employers' and workmen's delegates at the Conference respectively. Of the twelve persons representing the governments, eight were to be nominated by the members of chief industrial importance. This is an important provision, as it gives the chief industrial powers a preponderant influence on the senate of the organisation, which mainly determines the proposals to be submitted to the Conferences.

Article 405 of Part XIII. of the Treaty prescribes the procedure for carrying out the objects of the International Labour Organisation as set forth in the Preamble, which is explicitly referred to in the opening Article as setting forth those objects, and accordingly may be regarded as incorporated in the text of this organic international Statute, and as containing the basis of the code of a "law of nations" for securing social justice. It is worth quoting some of the provisions of Article 405—

> "When the Conference has decided on the adoption of proposals with regard to an item in the agenda, it will rest with the Conference to determine whether these proposals should take the form (*a*) of a recommendation to be submitted to the members for consideration with a view to effect being given to it by national legislation or otherwise, or (*b*) of a draft international convention for ratification by the members.
>
> "In either case a majority of two-thirds of the votes cast by the delegates present shall be necessary on the final vote for the adoption of the recommendation or draft convention, as the case may be, by the Conference . . .
>
> "Each of the members undertakes that it will, within the period of one year at most from the closing of the session of the Conference, or if it is impossible owing to exceptional circumstances to do so within the period of one year, then at the earliest practicable moment, and in no case later than eighteen months from the closing of the session of the Conference, bring the recommendation or draft convention before the authority or authorities within whose competence the matter lies, for the enactment of legislation or other action . . .
>
> "If on a recommendation no legislative or other action is taken to make a recommendation effective, or if the draft convention fails to obtain the consent of the authority or authorities within whose competence the matter lies, no further obligation shall rest upon the member."

Article 406 reads: "Any convention so ratified shall be registered by the Secretary-General of the League of Nations, but shall only be binding upon the members which ratify it."

Provision is also made for securing the enforcement, as against a defaulting member, of any convention which it has ratified, by a complaint to be laid before the Governing Body, who may refer it to a Commission of Enquiry. The Commission in its report is to recommend such steps as it may think proper to meet the complaint (if well founded), and "indicate the measures, if any, of an economic character against a defaulting Government which it considers to be appropriate." Any Government concerned in the complaint may finally refer it to the Permanent Court of International Justice of the League of Nations.

It will be noted that, if a convention or recommendation is adopted by the Conference, each member undertakes to bring one or the other before the authority or authorities, within whose competence the matter lies, and this whether such "member" has voted for it or not. The "member" can do this only through its Goverment, and the language about bringing it before the competent authority is apparently used in view of the distinction made in most constitutions between the executive and the legislature. In this connection it is interesting that some time back, when Mr. G. Barnes moved a motion in the House of Commons regretting that the British Government had not submitted to Parliament a draft convention passed at Washington, one of the law officers explained that the Government took the view that the ratification of a convention passed under Part XIII. of the Peace Treaty was itself an act in the nature of making a treaty, which by British constitutional practice was vested in the executive.

The aim of the makers of this part of the Treaty of Peace was not to establish international law in the sense of a set of agreements or rules governing the mutual relations of States, but to assimilate as far as might be practicable the municipal law in each of the adhering States in respect of the conditions of labour. If this were achieved, there would be (at least in fundamentals) one "law of the land" in such matters through the territories of the forty-six States, including Germany and Austria, belonging to the International Organisation of Labour, an operation on a much larger scale, comparable to that of the codification of the civil law of the German Empire in 1900, or of the establishment of the French civil code at the Revolution. Part XIII. of the Treaty itself contained the agenda for the first Conference, which was to be held at Washington in 1919, and stated that the High Contracting Parties "recognise that differences of climate, habits and customs, of economic opportunity and industrial tradition, make strict uniformity in the conditions of labour difficult of immediate attainment. But holding as they do that labour should not be regarded merely as an article of commerce, they think that there are methods and principles for regulating labour conditions which all industrial communities should endeavour to apply, so far as their special circumstances will permit." They continue—"Among these methods and principles, the following seem to the High Contracting Parties to be of special and urgent importance:—

"*First.*—The guiding principle above enunciated that labour should not be regarded merely as a commodity or article of commerce.

"*Second.*—The right of association for all lawful purposes by the employed as well as by the employers.

"*Third.*—The payment to the employed of a wage adequate to maintain a reasonable standard of life as this is understood in their time and country.

"*Fourth.*—The adoption of an eight hours' day or a forty-eight hours' week as the standard to be aimed at where it has not already been attained.

"*Fifth.*—The adoption of a weekly rest of at least twenty-four hours, which should include Sunday, wherever practicable.

"*Sixth.*—The abolition of child-labour and the imposition of such limitations on the labour of young persons as shall permit the continuation of their education and assure their proper physical development.

"*Seventh.*—The principle that men and women should receive equal remuneration for work of equal value.

"*Eighth.*—The standard set by law in each country with respect to the conditions of labour should have due regard to the equitable economic treatment of all workers lawfully resident therein.

"*Ninth.*—Each State should make provision for a system of inspection in which women should take part, in order to ensure the enforcement of the laws and regulations for the protection of the employed."

The first Conference met at Washington in the autumn of 1919 and passed a number of draft conventions on such matters as the limitation of the hours of work in industrial undertakings to eight in the day and forty-eight in the week, unemployment, the employment of women before and after child-birth, the night work of women and young persons, and the minimum age for the admission of children to industrial employment. A year later a Conference was held at Genoa, which dealt mainly with conditions of labour at sea, and in 1921 the Conference met at Geneva and dealt principally with agriculture. At the two later Conferences attempts were made to apply the principles adopted at the Washington Conference to the special conditions of these two industries, but it would be futile to pretend that the third Conference met and worked in the same spirit and temper as the Washington Conference. There was manifestly a reaction from the mood of solidarity which had been shown by the several classes of delegates in 1919. The employers' and workmen's delegates had in the meantime consolidated themselves into parties, and the Governments were perplexed by the divergence of opinion. If the intentions of the High Contracting Parties are to be carried out, it is manifest that in all countries which are members of the International Labour Organisation, there must be a continuity of policy with regard to labour questions, not subject to the conflict of parties, such as often obtains with regard to "national defence."

The International Labour Organisation is the "eldest daughter" of the League of Nations, and shares some of the difficulties which the parent institution has had to face.

Some of these are temporary, and others permanent. Thus undoubtedly the language of the preamble of Part XIII. of the Treaty and the statement of methods and principles quoted in this paper represent a point of view, that, for various motives strong at the moment, was more readily accepted on the morrow of the War by men of all shades of opinion and diversities of interest than at other times. At the present time the principles then accepted are questioned and challenged, and proposals to give effect to them are debated without enthusiasm and dissected in cold blood. The course of events during the last two years seems to be all against their realisation; the world at present seems less with the idealist than with the practical man. The tasks willed in hours of insight have to be carried out in grey days and with adverse omens. The new States, whose young legislatures cheerfully adopted "advanced" labour legislation are watched as they encounter difficulty after difficulty in putting it in practice. The futility of resisting the operation of economic laws is preached by the realist. We are passing through times not unlike those, the experience of which was formulated in such famous economic doctrines as that of the iron law of wages. Even if the discouraging hour passes away, the boldness of the conception and the ambitious character of the scheme will be exposed to the solvent influences of half-hearted friends and unfriendly critics. The spirit of the resolution proposed by the Belgian, French and Italian delegations, and adopted by the Commission on International Labour Legislation of the Peace Conference—that the International Labour Conference, under the auspices of the League of Nations, should be endowed with power to take, under conditions to be determined, resolutions possessing the force of international law—will be suspect with those who are not ready to surrender state rights to the international super-state. The maritime peoples may be jealons of the influence of small, new or inland states in the settlement of questions which they regard as within their peculiar province. The older peasant communities will think the times unpropitious for regulating the hours of labour for agricultural workers in times when more production is needed. Critics will be sceptical of legislating for the working classes from China to Peru. The friends of national autonomy will be alarmed at the prospect of all initiative in labour legislation being taken away from individual states and the development of municipal law being made subject to the dictates of an international authority.

Notwithstanding all this, out of various achievements one piece of work was done at Geneva which may fairly be cited as an admirable indication of the international method of handling industrial questions. That was the adoption of a draft convention regarding the use of white lead, and the ultimate result followed on very unpromising beginnings. Industrial disease is one of the evils referred to in the Preamble, and white lead poisoning is a disease from which reformers have long wished to protect workers, especially the users of the paints in which white lead is an ingredient. At the outset the matter seemed highly obscure and contentious. The preliminary enquiries in committee on technical and economic considerations were protracted and almost vexatious. The issues were not made clearer by the marshalling of numbers of experts. The persistent course of discussion did, however, throw light on dark places. Untenable positions were abandoned; the insincere and the irrelevant in plea and argument were sifted out. And when the case came before the full Conference, it was as it were presented to a disinterested tribunal after being fully argued before inferior courts. The Conference showed at its best in dealing with a concentrated question, in which the interested parties were a minority. It did its work on this subject in the manner that marks Parliamentary institutions working at a high level. Hence in his farewell survey of the work of the Conference Lord Burnham, while indicating certain cautions which he thought it necessary to utter as to a young institution finding its feet, was justified in ending on a note of encouragement.

THE AGRICULTURAL PRODUCTION OF CANADA.

ERNEST H. GODFREY, F.S.S.

Dominion Bureau of Statistics, Ottawa.

COMPRISING an agricultural estate the exact limits of which it is impossible to determine, the Dominion of Canada extends from the Atlantic to the Pacific Ocean, a distance exceeding 3500 miles, and from the United States boundary into the Arctic Circle. The total area of the Dominion is computed to be 3,729,665 square miles, which is 111,992 square miles larger than the United States, including the Alaska territory. Within the nine provinces, as at present constituted, the total land area covers 1,401,316,413 acres. Of this area, it was estimated on the basis of the census returns of 1911, that 440,951,000 acres, or 31 per cent., were possible of cultivation as farm land, whilst the census of that year showed that the land in the occupation of farmers was 109,948,988 acres, or not quite 8 per cent. of the total land area of the Dominion. Of the land in occupation, 48,337,823 acres represented improved land, and of this improved land 35,261,338 acres were actually devoted to field crops in 1911. These figures give some idea of the extent of the field open to agricultural exploitation in Canada.

Politically, the Dominion of Canada consists of nine autonomous provinces united federally under His Majesty's Dominion Government at Ottawa. At Confederation in 1867, only the four provinces of Nova Scotia, New Brunswick, Quebec and Ontario were united; but in 1870 was formed the new province of Manitoba; in 1871 British Columbia, and in 1873 Prince Edward Island joined the union, and in 1905 were formed the two new western provinces of Saskatchewan and Alberta, which with Manitoba are now generally referred to as the "Prairie Provinces." Boundary alterations between the provinces have been made from time to time, the latest being effected by the Boundary Extension Acts, 1912, when to Quebec was added the territory of Ungava and that part of Labrador which is within the Dominion of Canada;[1] the northern boundary of Ontario was extended to the southern shores of Hudson Bay, and the northern boundary of Manitoba was extended to the sixtieth parallel of north latitude to agree with the northern boundaries of the other two Prairie Provinces, Saskatchewan and Alberta.

I propose to describe briefly the progress achieved by the people of Canada in the cultivation of this domain, to give the distribution of the principal crops now grown, and to indicate something of the immediate future *possibilities* awaiting agricultural effort.

---

[1] The coast line of Labrador forms part of the Dominion of Newfoundland; but the boundary between Newfoundland and Canadian territory has not been strictly defined.

Epoch-marking events in the agricultural development of the Dominion include the construction of the Canadian Pacific Railway, completed in 1886, leading to the opening up of the Prairie Provinces and development of the Western grain trade; the M'Kinley Tariff of 1890, which caused diversion from grain-growing to dairying in Eastern Canada and the establishment of the export trade in cheese; the immigration policy, inaugurated after the general election of 1896 and culminating in the wonderful tide of immigration which characterised the present century up to the outbreak of the Great War; and the construction of the two additional transcontinental railway lines, known originally as the National Transcontinental and the Canadian Northern, both completed in 1914. That as the result of the war these two railway enterprises have experienced financial difficulties is a matter of common knowledge, but that under their recent re-organisation as the Canadian National Railway System they will play an important part in the future agricultural development of Canada cannot be doubted.

In 1870 the first census after Confederation showed that the area under wheat in the four provinces then confederated was little more than 1½ million acres; hay occupied about 3½ million acres and potatoes about 400,000 acres. In 1921 the acreage devoted to wheat was reported as over 23 million acres, that of hay and clover 10½ million acres, and that of potatoes 702,000 acres. During this period of fifty years the population grew from 3,689,000 in 1871 to 8,750,000 in 1921; but measured per 1000 of the population, the cultivation of wheat alone has grown from 472 acres in 1870 to 2628 acres in 1921.

Special characteristics of Canadian Agriculture.—Canadian agriculture differs from that of Great Britain in several essential features, both climatic and economic. Although parts of the Dominion, as for instance those near the British Columbian coast, approximate closely to conditions in Great Britain, over most of the country the severe frosts and deep snows prevent anything like the winter operations that are possible in England. Live stock, including sheep, must be housed, and sheep cannot therefore, as a rule, be kept in large flocks. Wheat, except in special localities, such as Southern Ontario and Alberta, is always a spring-sown crop. Of the comparatively small acreage of fall-sown wheat, a proportion, varying from about 5 to 10 per cent., is always winter-killed, and the areas must be resown in spring. On the other hand, growth during the summer is much more rapid than in Britain, and it is surprising to the old-country visitor how quickly vegetation progresses. The deep snows on the frozen soil provide gradually, when melting, welcome moisture for the newly sown crops. In the West, early frosts sometimes catch the grain before it is ripe and render it useless for milling or seeding. Therefore early ripening wheats, such as the Marquis, are of great importance. At the same time these summer frosts are regarded as entirely incidental to new lands; they disappear as cultivation extends.

Occasional periods of drought, hailstorms, outbreaks of rust, and depredations of injurious animals and insects are drawbacks experienced in Canada as in other countries. Vigorous efforts against such as are amenable to treatment are annually made with government advice and assistance.

It is desirable that mixed farming should become more general in the West, and to this end recent legislation has been enacted to facilitate the provision of rural credit for the permanent improvement of homesteads and the erection of buildings for live stock. One of the difficulties of Canadian farming is the provision of adequate labour, and as a rule a greater burden of manual labour falls upon the farmer himself than is the case in Britain. Wages are high, and in 1920 they averaged for the whole of Canada $86 (£17, 13s. 5d.) per month in the summer season, including board valued at $26 (£5, 6s. 10d.). This is, however, the highest point reached, and the rate has since receded.[1]

Canada as a Wheat-producing Country.—It is to its proved suitability as a grain-growing country, especially on the fertile prairies of the West, that the great agricultural development of Canada has been mainly due. Up to about 1880, the production of wheat, barley and oats was almost entirely confined to Eastern Canada; but the present position is that all but 5 per cent. of the area under wheat is in the three Prairie Provinces, and in Saskatchewan alone the area under wheat represents nearly 60 per cent. of the total in Canada.

With the development of the cultivation of wheat in the West have kept pace the arrangements necessary for its marketing and transportation. In no country of the world is the grain trade more highly organised than in Canada. Practically from the beginning of the Canadian grain trade, wheat has been sold by legally defined grades, and under successive parliamentary enactments the number of grades, partly dependent upon permanent quality and partly upon the effects of each season, has increased in number and complexity. The law on the subject was consolidated, and important new provisions were added by the Canada Grain Act of 1912. Elevators for the reception and storage of grain, especially wheat, were introduced into Canada shortly after the year 1880. During the present century they have increased with great rapidity. In 1901 the number was 523, with a capacity of 2,291,169 qrs.; in 1921 the total was 3,855, with a capacity of 28,901,703 qrs. For the year 1921 the total production of wheat is finally estimated at 37,607,263 qrs., the largest production since the record harvest of 1915, when the yield was 49,192,750 qrs. As showing the expansion in the cultivation of wheat since Confederation, the following table is instructive:

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[1] For the purposes of this article Canadian currency has been converted into British at the par rate of exchange: £1 = $4.86⅔.

AREAS AND YIELDS OF WHEAT.

Year.	Acres.	Qrs.	Year.	Acres.	Qrs.
1870	1,646,781	2,090,484	1914	10,293,900	20,160,000
1880	2,366,554	4,043,784	1915	15,109,415	49,192,750
1890	2,701,246	5,277,922	1916	15,369,709	32,847,625
1900	4,224,542	6,946,546	1917	14,755,850	29,217,856
1910	8,864,514	16,509,693	1918	17,535,902	23,634,419
1911	11,100,673	28,865,500	1919	19,125,968	24,157,550
1912	10,996,700	28,019,875	1920	18,232,374	32,898,663
1913	11,015,000	28,964,625	1921	23,261,224	37,607,263

The annual distribution of the Canadian wheat crop, including the quantities exported as wheat or wheat flour, is shown by the following table, which represents official calculations for the ten crop years ended 1921.

DISTRIBUTION OF WHEAT (*in Thousands of Quarters*).

Crop Year ended August 31.	Net Production	Imports of Wheat and Flour.	Available for Distribution.	Exports of Wheat and Flour.	Retained for Seed.	Balance for Home Consumption.
	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.
1912	24,319	49	24,368	12,315	2,406	9,647
1913	24,938	111	25,049	14,740	2,410	7,899
1914	26,068	83	26,151	16,631	2,457	7,063
1915	18,245	239	18,484	10,603	3,305	4,576
1916	45,358	35	45,393	36,224	3,362	5,807
1917	26,970	39	27,009	21,350	3,228	2,431
1918	26,999	33	27,032	19,404	3,796	3,832
1919	21,213	40	21,253	12,942	4,184	4,127
1920	22,079	26	22,105	11,183	4,000	6,922
1921	30,660	74	30,734	20,895	5,088	4,751

In this table the net production is arrived at by deduction from the gross, of the estimated amount lost in cleaning, averaging 3 per cent., and the quantity unmerchantable, consisting of grain frosted, tough or otherwise unfit for use, except as food for live stock, and addition of the small quantity annually imported. During the ten years the exports have varied from the minimum of 10,602,750 qrs. in 1915 to the maximum of 36,224,350 qrs. in 1916. For the current crop year, ending 31st August next, after making the usual deductions and allowances for seed and home consumption, I estimate the exportable surplus at about 21,625,000 qrs. The *per capita* consumption of wheat as human food has generally been somewhat higher in Canada than in Great Britain or the United States; but during the war the Dominion showed considerable powers of self-restraint and economy, and the ratio fell for the four years, 1915 to 1918, to the low rate of 4·2 bushels. Formerly it was customary to assume about 6¾ bushels as the *per capita* consumption in Canada; but more recently the milling statistics have shown that the rate is not more than about 5 bushels. Canada, notwithstanding its relatively small population, is now the third largest wheat-producing country in the world. Eliminating Russia, her production on the average of the five years, 1915 to 1919, was exceeded only by the United States and British India, whilst as regards the quantity of wheat annually exported, Canada at present stands second, being next to the United States.[1]

Other principal Crops.—Next in importance comes the great oat crop of Canada, the acreage of which has increased from 5,368,000 in 1870 to nearly 17 millions in 1921. In 1920 Canada produced the record oat crop of nearly 531 million bushels (66,375,000 qrs.); but the average annual production is about 420 million bushels (52,500,000 qrs.), the bulk being used for the feeding of live stock. On the average, about 4 million qrs. are required for seed, under 1,250,000 qrs. are milled for human food, and a certain quantity, varying during the past ten years from 1,062,500 to 8,128,000 qrs., according to the surplus available, is exported. The Canadian hay crop has always been of economic importance, and considerable quantities are annually exported in compressed bales. The area in 1870 was returned as over 3,650,000 acres; in 1921 it was about 10,615,000 acres. The yield per acre averages 1⅓ ton.[2] In 1919 the record crop of 14,596,429 tons was reaped; last year, owing to drought, with the lowest yield per acre on record, viz., 18 cwt., the total amounted to only 10,148,214 tons. Potatoes are a crop grown for home consumption, with the exception of a reciprocal trade with the United States and a small export trade from the Atlantic provinces to Cuba and the West Indies. In 1870 the area under this crop was about 403,000 acres; last year it was nearly 702,000 acres. The highest yield was 3,584,769 tons in 1920; in 1921 it was 2,872,661 tons. The yield per acre averages about 3½ tons, the record yield being 4½ tons in 1920, and last year it was 4 tons.

Total areas and values of Field Crops.—To give some idea of the more recent annual expansion of the areas under field crops and of their total value the following table has been constructed. The figures cover the period from 1910 to 1921, and include therefore the critical years of the Great War.

It will be noticed that during the war the total acreage under field crops increased from 33,436,675 in 1914 to 51,427,190 in 1918, which represented a truly remarkable effort on the part of the farmers of Canada, whose numbers were largely diminished by the absence of the younger men on active service. Over the whole period of twelve years the increase in acreage was 29,079,178, or 95 per cent.

The great increase in total values was mainly due to the war; they reached their culminating point in 1919. The price of wheat, which rose to $2.37 (9s. 9d.) per bushel in 1919, receded in 1921 to 81 cents (3s. 4d.) per bushel. The prices of other crops, excepting hay and clover, have also fallen in like manner.

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[1] "The World's Wheat." By Sir JAMES WILSON, K.C.S.I. (*Journal Royal Statistical Society*, May 1921, p. 360).

[2] Throughout this article the ton is the long ton of 2240 lbs., and the cwt. the long cwt. of 112 lbs.

The total acreage under field crops does not include pasture. As a rule land in Canada is not devoted to permanent pasture as in the Mother Country. Usually it is laid down to grass for two or three years and is then ploughed in accordance with the farming rotation practised. For seven of the provinces, including all but Manitoba and Alberta, the area under land now seeded to grass is about 10 million acres.

AREAS AND VALUES OF FIELD CROPS.

Year.	Areas.	Value.	Year.	Areas.	Value.
	Acres.	£		Acres.	£
1910	30,556,168	79,009,664	1916	38,930,333	182,166,440
1911	35,261,338	122,851,476	1917	42,602,288	235,199,270
1912	35,575,550	114,532,731	1918	51,427,190	282,110,087
1913	35,374,930	113,583,156	1919	53,049,640	315,856,821
1914	33,436,675	131,215,097	1920	52,830,865	299,022,703
1915	39,140,460	169,606,657	1921	59,635,346	191,478,806

Results of the Harvest of 1921.—In order to bring under general review the present agricultural production of the Dominion, the following table is presented as showing the area, yield and value of all the principal field crops for the year 1921, together with, for comparison, the annual averages of the same crops for the five year period 1916–20 (*see* next page).

Special Crops.—Brief mention should be made of certain special crops, which, for reasons of climate, differentiate Canadian agriculture from that of Great Britain. Maize or Indian corn, usually referred to simply as "corn," is a particularly valuable crop in the warmer parts of Canada. It is sown late in the spring, has a rapid and luxuriant growth, and, cut green as a silage crop, makes an invaluable winter food for dairy cattle. It is grown principally in Quebec and Ontario. Buckwheat is another regularly grown field crop of the Dominion, confined mainly, however, to the Eastern Provinces. Field beans, of the haricot variety, is also a special Canadian crop, used largely for canning purposes with pork as a highly nutritious and easily portable food for lumbering camps. The tobacco growing industry is fairly well established in parts of Quebec and Ontario, the production reaching nearly 50,000,000 lb. in 1920, but, owing to a smaller acreage caused by lower prices, falling to a little over 13,000,000 lb. in 1921. To farmers possessing groves of commercial size, the maple tree is an additional source of income. The trees are tapped annually in March and April when the sap rises after the winter. The industry is confined to the provinces of Quebec, Ontario, New Brunswick and Nova Scotia. Since Confederation, the average yearly production of maple sugar has varied from 13 to 20 million lb. It is estimated that the industry, which represents an annual value of almost $2,000,000 (£410,959), is carried on by about 50,000 farmers. In 1921 the production in Quebec was returned as 12,228,544 lb. of maple sugar, as compared with 15,615,161 lb. in 1920, and of maple syrup at 1,375,635 gallons, as compared with 1,444,649 gallons in 1920. The production in Quebec represents all but about 5 per cent. of the total for Canada.

AREA AND YIELD OF CROPS IN 1921.

Field Crops.	Area.	Yield per Acre.	Total Yield.	Average Price per Quarter.		Total Value.
	acres.	bush.	qrs. *thousands*	s.	d.	£ *thousands*
Fall wheat 1921	720,635	21·50	1,940	73	6	3,256
Average 1916–20	689,421	22·25	1,914	65	0	6,241
Spring wheat 1921	22,540,589	12·75	35,667	26	4	46,662
Average 1916–20	16,278,140	13·10	26,638	58	10	78,577
All wheat 1921	23,261,224	13·00	37,607	26	7	49,918
Average 1916–20	16,967,561	13·50	28,551	49	5	84,817
Oats 1921	16,949,029	25·25	53,279	11	2	30,081
Average 1916–20	13,980,453	31·00	54,116	21	4	58,216
Barley 1921	2,795,665	21·25	7,464	15	6	5,806
Average 1916–20	2,509,267	23·50	7,370	32	10	2,091
Rye 1921	1,842,498	11·75	557	13	8	3,164
Average 1916–20	463,663	15·85	919	46	0	2,117
Peas 1921	192,749	14·25	346	64	4	1,118
Average 1916–20	200,669	16·50	412	93	6	1,924
Beans 1921	62,479	17·50	136	95	6	648
Average 1916–20	101,855	15·50	198	175	2	1,732
Buckwheat 1921	360,758	22·75	1,029	29	4	1,497
Average 1916–20	421,756	21·00	1,101	46	4	2,555
Mixed grains 1921	861,136	25·75	2,784	20	4	2,856
Average 1916–20	708,996	34·50	3,067	36	6	5,582
Flaxseed 1921	533,147	7·75	514	47	6	1,220
Average 1916–20	1,033,336	6·55	843	87	6	3,686
Corn, husking 1921	296,866	50·25	1,863	27	4	2,531
Average 1916–20	242,719	49·00	1,488	46	10	3,478
			tons. *thousands*	Per ton.		
Potatoes 1921	701,912	4·09	2,873	117	7	16,880
Average 1916–20	693,690	3·91	2,716	146	0	19,838
Turnips, Mangolds, etc., 1921	227,675	7·76	1,767	61	11	5,470
Average 1916–20	258,538	7·80	2,017	81	1	8,178
Hay and Clover 1921	10,614,951	·96	10,148	108	5	55,020
Average 1916–20	9,513,118	1·35	12,977	79	11	50,880
Grain hay[1] 1921	57,603	2·41	139	93	0	645
Average 1916–20	60,501	2·12	128	142	3	914
Grain hay[2] 1921	...	...	1,012	46	0	2,329
Alfalfa 1921	263,892	2·24	591	91	10	2,715
Average 1916–20	174,206	2·13	370	96	0	1,593
Fodder corn 1921	585,395	9·70	5,680	32	8	9,222
Average 1916–20	452,478	7·88	3,566	30	0	5,365
Sugar beet 1921	28,367	8·44	239	29	11	358
Average 1916–20	21,558	8·45	182	49	5	451

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[1] British Columbia.

[2] Alberta.

There are three sugar factories in Canada which manufacture sugar from Canadian grown sugar-beets. They are situated at Chatham, Wallaceburg and Kitchener in the province of Ontario, and are under the control of the Dominion Sugar Company, Limited, of Chatham. In 1920 the production of refined beetroot sugar amounted to 89,280,718 lb., of the value of $12,856,424 (£2,641,731). This quantity was produced from 306,250 tons of beet, of the value to growers of $5,307,243 (£1,090,529), and was the produce of 34,491 acres. The yield per acre was 8·87 tons, of the average value to the growers of $3·56 per ton.

As a result of the War, a new industry was established by the growth of flax for fibre, and in 1919 the total value of the products attained to $5,523,000 (£1,134,863). In 1921, however, the area sown to fibre flax dropped to 6515 acres from 31,000 acres in 1920, as a consequence of the fall in prices—a set-back which it is hoped may be but temporary, as various mechanical improvements lately introduced are full of promise for the future.

Farm Live Stock.—Canada is eminently adapted to the rearing of farm animals, and has long enjoyed absolute immunity from virulent contagious disease. Great success has also been attained in the control of glanders, anthrax, and swine fever, whilst advanced measures are adopted against bovine tuberculosis. The principal breeds of Great Britain, including Shorthorns, Herefords, Aberdeen-Angus, and Ayrshire cattle, are well represented, as well as Holsteins, and there are a few herds of Galloways. There are also useful breeds, distinctly Canadian, such as the French-Canadian horse and the French-Canadian cattle.

The favourite draught horse on the farm is the Clydesdale, animals of fairly good scale being usually preferred. The Percheron is also in high favour, and the Belgian horse has its devotees.

The following table shows the detailed distribution of the farm animals of Canada for the years 1918 to 1921:

NUMBER OF STOCK.

Description.	1918.	1919.	1920.	1921.
	No.	No.	No.	No.
Horses	3,609,257	3,667,369	3,400,352	3,813,921
Mules	10,261	15,102	9,055	10,424
Milch cows	3,538,600	3,548,437	3,504,692	3,736,832
Other cattle	6,507,267	6,536,574	6,067,504	6,469,373
Total cattle	10,045,867	10,085,011	9,572,196	10,206,205
Sheep	3,052,748	3,421,958	3,720,783	3,675,860
Pigs	4,289,682	4,040,070	3,516,678	3,904,895

The total values of the live stock of Canada in 1920 was estimated at £213,954,624—including £74,245,468 for horses, £115,376,694 for cattle, £7,656,780 for sheep, and £16,675,682 for pigs. The number of farm poultry in the Dominion in 1921 was returned as follows: hens, 34,340,474; turkeys, 1,199,494;

geese, 880,014; and ducks, 762,135. The total value of farm poultry in 1920 was placed at £7,606,149.

A branch of the live stock industry which has lately attained special prominence in Canada is the raising in captivity of wild fur-bearing animals. Whilst the silver fox has proved most suited to domestication, success has also been attained with mink, skunk, raccoon and karakule sheep. Prince Edward Island is the principal location for fox farming; and there, in addition to joint-stock ranches, a considerable number of farmers possess small ranches within the farm woodlands, from which they thus derive no small part of their total income. The earliest official statistics of the industry, published by the Prince Edward Island Department of Agriculture, showed that in 1913 there were in the Island 277 fox farms, with a total of 3130 foxes. Annual statistics of the industry are now published by the Dominion Government, and the latest report shows that in 1920 the total number of fox farms was 587, of the value of £1,217,568, including £247,108 for land and buildings, and £970,460 the value of the fur-bearing animals. Of the total number of fur-bearing animals in captivity in 1920, viz. 16,529, foxes numbered 15,174 and karakule sheep 1100. It is interesting to note that experiments in breeding for the production at will of the highly esteemed silver fox were successful through the application of Mendel's Principles of Heredity.[1]

The Dairying Industry.—The establishment of the dairying industry upon a factory basis has been one of the most significant agricultural developments since Confederation. As already mentioned, the production of grain on the Prairie Provinces and the effect of the McKinley Tariff of 1890 rendered grain growing in Eastern Canada unprofitable, and the farming situation was only saved by the increase of dairy products, for which a market was gradually built up with the United Kingdom. In 1882, the introduction from Denmark of the centrifugal cream separator led to an important expansion of the industry. The following table illustrates the progress of the manufacture of creamery butter and factory cheese since 1900:—

Year.	Establishments.	Creamery Butter.		Factory Cheese.	
	No.	Cwts.	£	Cwts.	£
1900	3,576	322,024	1,487,871	1,971,726	4,566,046
1907	3,515	410,102	2,249,807	1,828,369	4,848,829
1910	3,625	577,632	3,214,899	1,784,858	4,435,709
1915	3,513	749,934	5,010,626	1,641,856	5,567,912
1916	3,446	737,160	5,541,031	1,722,934	7,297,112
1917	3,418	780,396	7,032,982	1,740,317	8,459,703
1918	3,373	833,021	8,601,195	1,561,414	8,107,505
1919	3,282	927,596	11,583,283	1,485,910	9,161,540
1920	3,161	997,247	13,073,670	1,332,159	8,034,425

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[1] *Census and Statistics Monthly*, May 1913, p. 92; May 1914, p. 110.

Altogether, including miscellaneous products, the value of the output of the dairy factories in 1920 was £30,069,137, not including the large amount of dairy or home-made butter, estimated at about 1,116,071 cwt., nor the small amount of home-made cheese (12,172 cwt. in 1910).

The Possibilities of the Immediate Future.—Indication has already been given of the immense future possibilities of agricultural development in Canada; but the estimates quoted have reference rather to remote periods, and are dependent upon time for increase of the necessary population. In conclusion, therefore, I would refer briefly to the more immediate future. Of the Crown lands under the administration of the Dominion Government, 25,649,800 acres were, on 1st January 1921, available for homestead entry. In the northern parts of the three Prairie Provinces are large tracts only partially explored and entirely unsurveyed; their total area is placed at 285,362,459 acres, of which 22,384,720 acres are water-covered. In Eastern Canada the Crown lands are under provincial administration. Their area in Nova Scotia is nearly 817,000 acres, and in New Brunswick about 7¼ million acres. In Quebec there are about 6½ million acres of lands available for agricultural settlement. In Ontario more than 20 million acres of the very finest arable land await clearance and the plough, and the new National Trans-Continental Railway renders settlement on these lands practically possible. In British Columbia the area estimated as suitable for agriculture is 22,608,000 acres. Altogether, therefore, some 57 million acres may be regarded as possible of immediate settlement if the necessary number of settlers can be secured. Since the conclusion of peace, a great deal has been done by both the Dominion Parliament and the Provincial Legislative Assemblies to facilitate settlement upon the land of returned soldiers. More than 5 million acres are now occupied by settlers under the Soldiers' Settlement Act of the Dominion Parliament. Whilst the immigration returns are beginning to show recovery from the check occasioned by the war, the latest return of 148,477 immigrants for the year ended 31st March 1921 is a long way behind the record of 402,432 in 1913.

STATION FOR THE TESTING AND REGISTRATION OF AGRICULTURAL PLANTS.

THE urgency of establishing a Scottish Station for the Testing and Registration of distinct varieties of agricultural plants had been pressed upon the Board by representative bodies for several years prior to 1917, when the Board received two deputations from the Highland and Agricultural Society. In February 1918 a further conference was held of representatives of the above societies and trade associations directly interested in the subject. The principle of establishing a station was unanimously approved, and the

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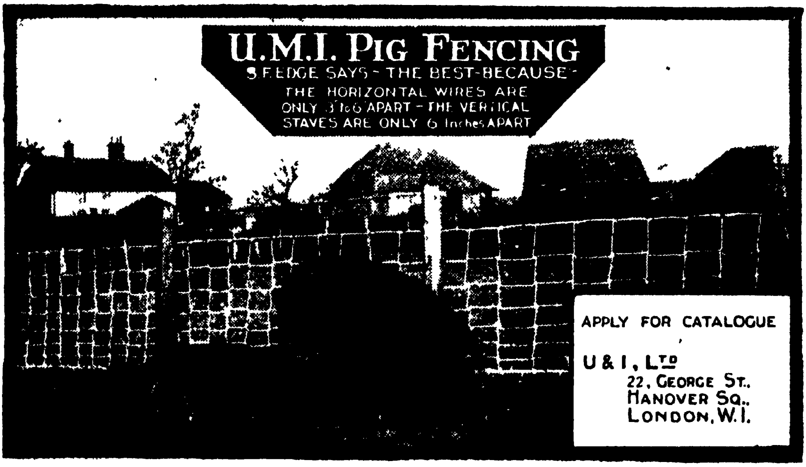

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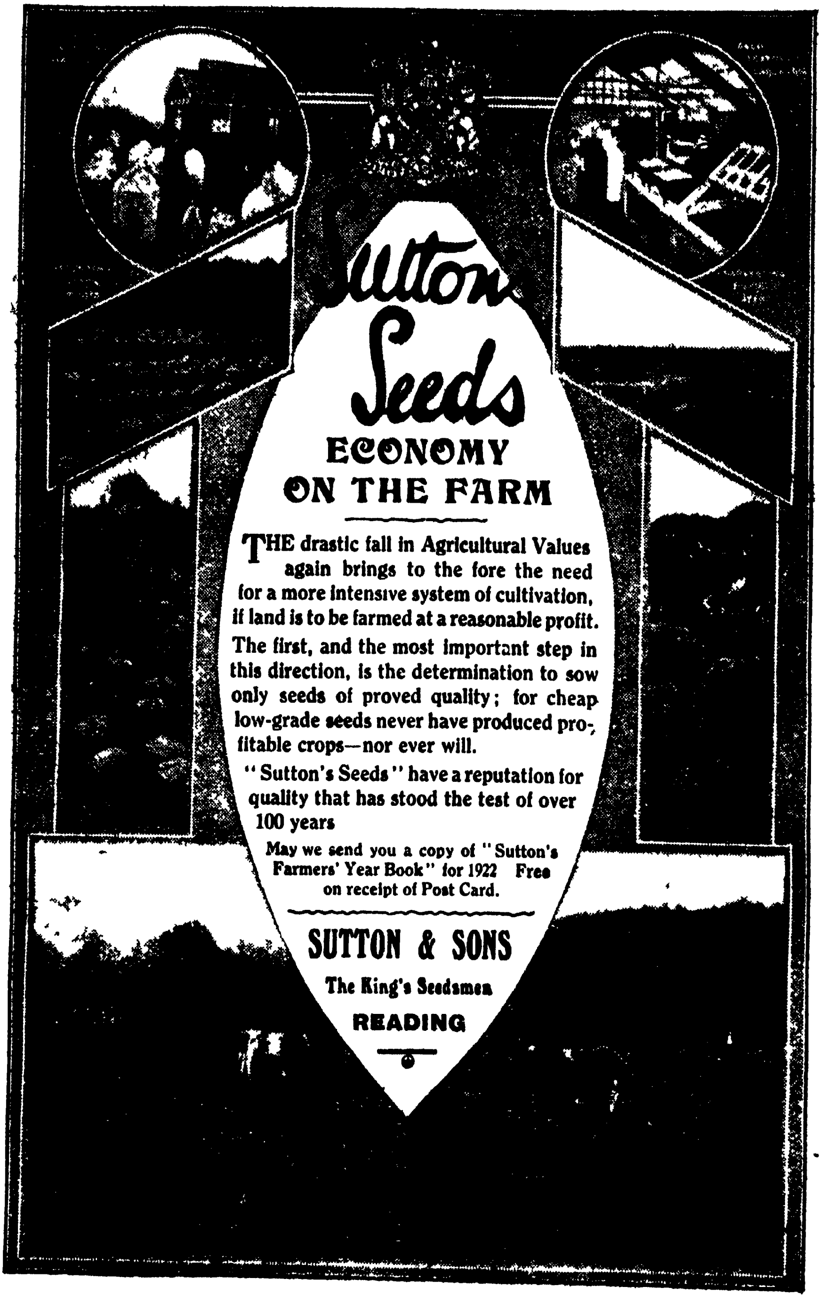

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READING

composition of a Standing Committee to assist and advise the Board in the management of the station was determined as follows:—

Highland and Agricultural Society	3	Representatives.
Scottish Chamber of Agriculture	2	do.
National Farmers' Union	2	do.
Scottish Seed Trade Association	4	do.
Agricultural Colleges	3	do.
National Association of Corn and Agricultural Merchants	1	do.
Total	15	

Although the Board had authority to secure suitable land for the purposes in view, it was not until Whitsunday 1920 that they were able to acquire a suitable farm at a satisfactory price. The farm in question is East Craigs, situated in the parish of Corstorphine, and within the boundaries of the city of Edinburgh. Of this farm the Board have sold 27 acres to the Scottish Society for Research in Plant Breeding, and the remaining area of 84 acres has been retained for the purposes of the Registration Station. It is of obvious advantage that the two stations for plant breeding and plant registration should be in contact and close association.

The objects of the Plant-Testing and Registration Station are briefly:—

(1) To classify existing varieties of the agricultural plants which are of importance to Scottish agriculture, and to register varieties which are authenticated as new;

(2) To publish accurate information regarding the type, cropping capacity, immunity from disease, relative merits, etc., of varieties, as ascertained by testing;

(3) To carry out comparative tests of special strains of these varieties, and so enable the highest standard of production of established varieties to be maintained;

(4) To reduce the number of commercial names, descriptive of supposed strains of standard varieties (large numbers of these so-called strains have no distinctive character). This will assist in preventing a common species of fraud which consists of marketing an old variety under a new name and at an enhanced price, to the detriment of the interests of genuine breeders of agricultural plants.

(5) The station will also act for the general agricultural community in the settlement of any disputes regarding the authenticity of stocks, and it will also assist the Board in the administration of the Seeds Act, 1920. Under this Act it is incumbent upon the seller of cereal, potato and clover seeds to state the name of the variety sold.

At a meeting of the Standing Committee on 25th January 1921, it was decided for the first year to concentrate chief attention on potatoes and oats. A Potato Synonym Sub-Committee and a Cereal Sub-Committee were appointed for the purpose of advising the Committee and the Board. The membership of these committees is such as to give absolute confidence to breeders and growers.

The Potato Synonym Committee have prepared for the approval of the Standing Committee and the Board, a schedule of conditions for the registration of potato varieties. During the year they have also inspected the samples of growing potatoes undergoing tests at the station, and have made a report as to which of these are distinct varieties and which are identical with existing standard varieties.

At the suggestion of the committee, a short guide has been prepared by the Board for the assistance of breeders of new varieties of the potato, with the view to reducing, as far as possible, the submission of samples that have no commercial value. The guide is printed at the end of this article.

The conditions proposed for the registration of new varieties of the potato are as follows:—

1. The Board of Agriculture for Scotland will maintain a station or stations for the purpose of testing new and improved varieties, and will issue certificates of registration of such varieties as are deemed worthy of registration.

2. The operations of the station will be directed by a Standing Committee of Management, consisting of four representatives of the Board and fifteen other members representative of agricultural and seed trade interests. An Advisory Sub-Committee (Synonym Committee) will deal with the potato tests, will draw up, for the approval of the Standing Committee, regulations regarding the conditions of registration, will consider the report of the technical officers of the Registration Station and advise the Board regarding the issue of certificates of registration in respect of any variety submitted.

3. Registration shall only be applied to varieties which are new varieties developed as seedlings from true seed derived from a potato berry.

3A. The Board will, in the meantime, provide facilities, free of charge, for the testing of immunity of new seedling varieties during the first two years of their development. This test will be applied to single tubers, and will enable raisers to discard non-immune seedlings.

4. A variety may not be accepted for trial with a view to registration unless this preliminary test (*see* 3A) has been applied and passed, and unless the Board, on the recommendation of the Synonym Committee, and on the report of an authorised inspector, are satisfied that the existing stock is unmixed with any other variety.

5. Any variety accepted for registration will be subjected to the usual test for immunity from wart disease, and will be tested for general qualities at several other stations.

6. Registration of a variety will only be made on conclusive proof that:—

(1) The variety is immune from wart disease.

(2) The variety is of a grade of general excellence, at least equal to that of standard immune varieties of the same period of maturity, or has a special excellence in one or more respects which will make it adapted to a particular area.

(3) In the case of a maincrop variety, the variety is satisfactorily resistant to late blight and other diseases.

A registration fee of 5s., which will cover charges for registration and for immunity test, will be payable at the time of submission of the sample. The weight of the sample shall not be less than 7 lb.

7. The name of the variety must be approved by the Synonym Committee.

8. The duration of the test of any variety submitted shall be at the discretion of the Synonym Committee, but shall in no case be less than two years, and registration shall not be effective until the test is completed.

9. The Board will cause records to be kept of all stocks of any variety which are accepted for registration, but records of any part of the stock may be cancelled at any time when such portion of the stock is not maintained in a state of purity in accordance with the rules imposed.

10. The raiser of any variety submitted shall, in the event of distribution of any part of his stock before registration is effected, report to the Board the names of the persons to whom the distribution is made, and the holders of the stocks shall likewise report any further distribution; otherwise, in the event of a holder (not being the raiser) of a stock being unable to produce evidence to prove that his stock has been derived from the original stock, the stock shall not be regarded as of the registered variety. The Board may inspect crops of registered immune varieties, and issue certificates of purity in respect of such crops as are found to contain less than 0·5 per cent. of plants or tubers of other varieties.

11. On the approval of any variety for registration as a new variety, the grower, or growers, of any part of the stock shall permit his crop to be inspected by an authorised officer of the Board at times to be mutually agreed upon.

When the stocks are proposed for distribution and have been certified by authorised officers to be entirely free from plants of other varieties, the Board will make arrangements for the issue of a certificate which shall be valid for one year only to the holder of authentic stocks of the variety in question.

12. The certificate of registration will state:—

(1) The name of the raiser.
(2) The name of the grower.
(3) The authorised name of the variety.
(4) That the variety is immune.
(5) The registration number allotted to the variety.

13. The holder of the stock shall retain the certificate, and shall, on distribution of the variety, affix a description of the seed potatoes as required by the provisions of the Seeds Act, 1920, and any regulations issued under that Act. The seed potatoes shall also be accompanied by the official registration number of the certificate. The holder shall also notify the Board's Registration Station of the name of the persons to whom the seed potatoes are supplied.

14. The stock of any variety submitted for test shall, at the completion of the test, be the property of the Board of Agriculture for Scotland, but the sender shall have the first option of taking back the stock on payment of the expenses incurred by the Board in testing the stock, such expenses to be assessed by the Committee. But the Board shall have power to retain a sufficient quantity (not exceeding 28 lb.) of the stock for reference purposes.

15. Any dispute regarding any matter having reference to the registration of any variety of potatoes shall be submitted to the Synonym Committee, and the decision of that Committee shall be final.

The Cereals Sub-Committee have prepared for the approval of the Standing Committee and the Board a schedule of conditions for the testing and registration of cereals. They have also reported to the Standing Committee on the results of the trials of varieties of oats carried on at the station during the year.

These trials comprised :—

(1) The growing in five plots of 200 seeds each of 53 different samples of seeds of pure stocks of the oat varieties already on the market in this country, and in countries having a somewhat similar climate. This is for the purpose of a preliminary investigation of the botanical characters of the common commercial varieties of this country and of foreign varieties which are believed to have affinities with them ; also with a view to taking records for the purposes of comparison with new varieties submitted for testing in subsequent years. For this purpose samples were obtained from Messrs Garton and Messrs Webb in England, from the Gröningen Seed Growers' Association, from the Canadian Farmers' Association, and from the Government of the United States of America ;

(2) The growing for record purposes of twelve different samples of stocks of Potato oats obtained from different districts in Scotland, the quantity of each sample of seed being one quarter, and each sample thus occupying about 2 acres of land. Unfortunately, owing to the mixed character of the samples obtained and also owing to the unfavourable conditions of the season—excessive drought, etc.—little useful information has been gained from this test;

(3) The growing for record purposes of one extensive crop each of "Sandy" and "Tam Finlay." Again owing to the unfavourable season, it was not possible to obtain reliable records from this test.

The conditions proposed for the registration of new varieties of cereals are as follows:—

1. The Board of Agriculture for Scotland will maintain a station, or stations, for the purpose of testing new and improved varieties, and will issue certificates of registration of such varieties as are deemed worthy of registration.

2. The operations of the station will be directed by a Standing Committee of Management, consisting of four representatives of the Board and fifteen other members representative of agriculture and seed-trade interests. An Advisory Sub-Committee will deal with the cereal tests, will draw up regulations regarding the conditions of registration, will consider the report of the technical officers of the Registration Station, and advise the Board regarding the issue of certificates of registration in respect of any variety submitted. The Sub-Committee may co-opt members other than members of the Committee of Management for the purpose of obtaining expert advice.

3. Registration may be applied to [1] selected stocks of standard varieties or to [1] new varieties developed by hybridisation, or by selection of sports—on the basis of a report as to the identity and quality of these by the director of the Board's Seed-Testing Station after consultation with the Advisory Committee, and of a report by an inspector of the Board on the growing and handling of the crop.

3A. This registration scheme shall only apply to oats, until such time as the Board have facilities for testing other species.

4. A variety proposed for registration may not be accepted for test unless a crop has been previously inspected by a duly authorised inspector, and unless the Advisory Sub-Committee are satisfied, on the report of that inspector, that a sufficient quantity of the stock of the variety exists to justify a test, and that the variety has been subjected by the raiser to a satisfactory preliminary test.

5. Stock of a variety which has undergone the full station test will only be considered eligible for registration if it has been hand-threshed through all stages of its multiplication up to 10 bushels.

6. Reports on any variety will be based on the results of competition and comparative trials of the variety at several centres.

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[1] *Definitions.*—Mass selected stock is stock derived from hand-selected plants of the true type of the variety from which selection is made.

Pedigree strains are uniform strains developed from a single seed or head in plots, which from year to year are adequately isolated on all sides from any other plot by means of interpolated lines of another cereal.

Pedigree hybrid strains are uniform strains developed from crosses in a similar fashion.

7. Registration of a variety or of a stock will only be made on conclusive proofs that :—

(1) The stock is superior in some respects to representative commercial stocks of the same variety ; and

(2) The (new) variety is superior in some respect to the best standard varieties of similar type.

A registration fee of 10s. will be payable at the time of submission of the first sample. The size of sample to be submitted for the purposes of testing shall not be less than 4 ounces, except by special arrangement to meet the case of the establishing of the identity of a *new* variety, of which the quantity of stock seed may be restricted.

8. The duration of the test of any variety submitted shall be at the discretion of the Advisory Committee and registration shall not be effective until the test is completed.

9. The Board will cause records to be kept of all stocks of seed of any variety which are accepted for registration, but records of any part of the stock may be cancelled at any time when such portion of the stock is not grown and handled or maintained in a state of purity in accordance with the rules imposed.

10. The registration of stocks will only be maintained for a period of three years from the first distribution of the seed by the grower who received the first certificate of registration.

11. On the approval of any variety for registration as a new variety or of any stock as an improved stock, the grower of such variety or stock shall permit his crop to be inspected by an authorised officer of the Board at times to be mutually agreed upon. When the seed is proposed for distribution and has been grown in a manner to satisfy the Board's officer, the Board will make arrangements for that or other officer to inspect the threshing of the crop and if the seed is found by him to be free from impurities including :—

> Seed of other varieties or species. Seed of Charlock, Runch, Bindweed, Hemp Nettle, Wild Oat and Dock in greater quantity than one seed in 4 ounces, or of other weeds in appreciable quantity,

to seal the grain in bags with an official seal as it comes from the mill or fanning machine.

Certification of stocks applies only to Scotland, but raisers of new varieties or stocks outwith Scotland may have their varieties tested and registered.

12. The Certificate of Registration will state the name of the variety registered, its origin, its mode of selection (mass selected, pedigree strain or hybrid strain) and will carry an official reference number.

13. The holder of the stock shall retain the certificate and shall on distribution of the seed affix a description of the seed which shall be accompanied by the official registration number of the certificate, and shall notify the Board's Registration Station of the name of the persons to whom the seed is supplied.

14. The stock of any variety submitted for test shall, at the completion of the test, be the property of the Board of Agriculture for Scotland, but the sender shall have the first option of taking back the stock on payment of the expenses incurred by the Board in testing the stock, such expenses to be assessed by the Committee. But the Board shall have power to retain a sufficient quantity (not exceeding half a bushel) of the seed for reference purposes.

15. Any dispute regarding any matter having reference to the registration of any variety of cereals shall be submitted to the Advisory Committee on Cereals and the decision of that Committee shall be final.

The reports of the two Sub-Committees, together with the programmes for the current year, are at present under the consideration of the Standing Committee. The suggested programmes for 1922 include:—

POTATOES.—All varieties submitted for test as new varieties—whether for immunity test or registration—will be planted in small plots of twelve tubers at the Registration Station for the following purposes:—

(1) Submission to Synonym Committee;
(2) Collection of observations on the general botanical features of each variety;
(3) Conservation of a stock of seed tubers of each variety for further trial in subsequent years.

Preliminary tests of the time of maturity and capacity for cropping will be made for the purpose of formulating a basis of classification according to date of maturity and for the purpose of obtaining a reliable method of estimating yield. These plots will be laid down in quadruplicate on a definite plan.

New immune varieties introduced subsequent to 1920 will be grown for seed for inclusion in maturity and yield tests in 1923.

A reference collection of known varieties will be commenced, in order that material for comparison of varieties may be available to the Synonym Committee and to the Board's Inspectorate. This will be duplicated at Philpstoun Wart Disease Testing Station.

Duplicate tests of varieties in respect of immunity from Wart Disease will be continued at Philpstoun as heretofore.

OATS.—1. Observations on the botanical characters of common commercial varieties of oats will be continued with a view to obtaining a basis of classification. Varieties of the Abundance type will be subjected to close observation, and selections of the quasi-indigenous types, Potato, Sandy and Blainslie will be grown with a view to making an analysis of the forms included in these varieties.

2. A well-known breeder has expressed a desire to submit three of his improved selections, Potato, Sandy and Gordon for registration. It is proposed to obtain 14 lb. of each of these and to sow each in eight separate blocks 14 yards by 3 yards, interspersed with similar blocks of commercial samples of Potato and Sandy for comparison.

3. Stock plots of common varieties from stocks purified in 1921 will be grown as a source of pure seed.

SWEDES AND TURNIPS.—Arrangements have been made for the observation of some sixty or seventy commercial varieties of swedes and turnips with a view to establishing:—

(1) The individuality of commercial varieties in terms of morphological or physiological characters;
(2) A correct basis for judging the value of special strains.

It is proposed in this connection to collect observations on:—

(1) Type and peculiarities;
(2) Time of ripening, winter hardiness, and keeping quality;
(3) Chemical composition;
(4) Disease resistance;
(5) Any special marketable qualities.

It is also proposed to find means of conducting this enquiry in collaboration with the North of Scotland College of Agriculture and the Rowett Research Institute by means of actual feeding tests.

HERBAGE PLANTS.—It is proposed to initiate an experiment to test reputed strains or varieties of Perennial Ryegrass, Red Clover and White Clover in terms of permanency.

Arrangements have been made with the Director of the National Institute of Agricultural Botany for the interchange of samples and for a certain duplication of tests, which will involve a comparison of the usefulness of the tested strains for both Scottish and English conditions. In the event of useful results being obtained as the outcome of the experiment, it is proposed that steps should be taken by the National Institute of Agricultural Botany to guarantee the identity of approved and registered strains.

The Board have an application from a well-known firm of seed merchants, for the registration of a new hybrid stock of White Clover. This can be included in the experiment with Wild White from various localities.

The material used for the experiment will be:—

(1) Strains of Ayrshire Perennial Ryegrass, Devon Eaver (if obtainable). There are several of these reputed strains in Ayrshire, mostly, however, not definite lines, but associated with certain districts;
(2) Strains of Single Cut Cowgrass and Perennial Red Clover, Cornish Marl Grass, Welsh Red Clover, etc.
(3) Strains of White Clover of reputed permanency, *e.g.*, Hobb's Wild White Clover; Wood's (Gloucester) Wild White Clover; Irvine's Hybrid White Clover; Danish Morso White Clover;
(4) Foreign samples of Red and White Clover for comparison and control.

The "seeds" will be sown under a light crop of barley. The Ryegrass will be sown in belts 36 yards long by 6 yards wide. Each belt will be divided into six, and the various samples of clovers will be distributed in the squares thus formed, each sample being repeated six times. Allowance is thus made for about forty samples of Ryegrass and forty samples of Clover. One-third of the crop will be seeded, one-third cut for hay, and one-third for continuous pasturage in 1923. Thereafter the whole area will be pastured for a period of four to five years.

SHORT GUIDE TO POTATO BREEDING AND SELECTION.

I.—PRODUCTION OF NEW VARIETIES.

The production of new varieties can be effected in only one way, viz., by means of the true seed taken from the potato berry or seed-ball, it being now generally accepted that neither tuber selection nor grafting is efficacious for this purpose.

As a general rule the potato is self-fertilised, but many varieties, *e.g.*, "Up-to-Date" are unable to set berries with their own pollen, while others, *e.g.*, "King Edward" very seldom flower. The varieties which set fruit naturally interest the potato breeder for two reasons—(1) the seed from the berries themselves may be sown for the production of new sorts, (2) (and this is perphaps more important) their pollen may be used to cross-fertilise non-fruiting flowering varieties.

Free-fruiting varieties are indicated in the following publications :—

(*a*) "Maintenance of Pure Stocks of Immune Varieties of the Potato." (Board of Agriculture for Scotland)

(*b*) "Guide to the Craibstone Experiments, 1921." (North of Scotland College of Agriculture).

It must not be assumed that the pollen of every self-fruiting variety will be potent on other varieties ; potency or impotency can only be determined by actual trial.

Nor must it be assumed that standard varieties are the only varieties which should be used as parents. Seedlings in themselves not suitable for the market, may nevertheless be very prolific pollen producers and have other features which make them suitable for use as parents.

Composite crossing (as, for example, a crossing of a seedling derived from a cross on British Queen × Flourball with a seedling derived from a cross on Up-to-Date × Majestic) may result in producing a variety which combines desirable characters peculiar to each of the original parent types.

Although some useful standard varieties are reputed to have been raised from seed taken from naturally-set berries the general opinion among potato-breeders is that self-fertilised seed, especially when it is the product of selfing through more than one generation, is not so likely to produce a large number of useful types from which to select as is cross-fertilised seed. Many standard varieties, however, are the first generation products of crosses and seed from their self-set berries may be as capable of producing useful varieties as seed taken from a berry which is the result of cross fertilisation.

Potato varieties have been elaborated through generations of cross-breeding; the seed of self-set berries of popular varieties will probably carry many characters in a blended (heterozygous) condition and will give rise to plants which differ among themselves and are distinct from the parent plant from which the berry was taken.

A high percentage of the natural seedlings of a few varieties, *e.g.*, "Abundance," "Ally" and "President" are indistinguishable from the parent type; on the other hand natural seedlings of a variety, *e.g.*, "Majestic," often show great diversity.

The seedlings derived from seed (of a berry) produced by cross-fertilisation frequently show resemblances to each parent but the isolation of any plant which possesses all the desirable qualities of both parent types is hardly to be expected—even if selection is applied to large numbers of seedlings of the same parentage—and has not been known to have been accomplished.

Inevitably when potato seed is sown, the majority of the resulting seedlings are unmistakably useless, and should be discarded forthwith. (*See* paragraph on "Selection of Seedlings.") Probably about 10 per cent. to 20 per cent. of the seedlings qualify for retention in further trials. This percentage will be much further reduced at the end of the second year if judicious elimination of all seedlings which show bad features or are susceptible to disease of any kind is practised. The Board of Agriculture for Scotland provide facilities for testing the susceptibility to Wart Disease of single tubers of seedlings at this early stage.

If the breeder continues the process of elimination from year to year, he will be fortunate if at the end of the fourth or fifth year he has found one variety of outstanding merit out of one thousand seedlings.

II.—PROCEDURE IN OBTAINING AND SOWING THE SEED.

The breeder has a choice of so many varieties which, because they bloom but do not set fruit naturally, can be used as female parents without removal of the anthers that he is wasting time in using as female parents varieties which require to have their anthers removed to prevent self-fertilisation. Having selected a suitable female parent plant, say of "Up-to-Date" or "British Queen," he should wait until the flower bud is bursting and the points of the pistil are separate and sticky. This is the best time for cross pollination, but the operation may also be done later while the bloom is fully open. He should then take a ripe anther from a plant of a selected naturally fruiting variety, and slip the points of a pair of forceps or the fine blade of a penknife up one or other side of the inner face of the anther towards the pore at the top, where it dehisces and so collect a small quantity of the pollen. He should then transfer this pollen directly and gently on the sticky stigma of the female parent, taking care to cover the whole surface. The forceps or penknife blade should be cleaned absolutely free from pollen before each operation. For commercial work it is unnecessary and, in fact, rather harmful to enclose the flower thus pollinated in a bag or envelope. Coloured wool or silk tied round the flower stalks should be used to indicate the variety of the pollen parent, a different colour being assigned to each variety. It is important that the colours should be fast.

If pollination is effective it is followed by the appearance of the berry which is usually heralded by a shrinking of the pistil, the closing of the petals and the swelling of the ovary. The effect of cross-fertilisation does not extend beyond the floral parts, and this fact should be patent to any observer; there are no grounds for the fallacious idea still persistent among amateur breeders that crossing has the effect of altering the varietal potentialities of the tubers of the actual plant on which the crossing operation is performed.

The berries should be left on the plants as long as possible, but gathered before the stalks begin to rot and before the berries fall off. When the berries are nearly full grown it is advisable to support them in a small muslin bag attached to the inflorescence stalk. After harvesting, each berry should be put in a small bag or envelope properly labelled and should then be allowed to ripen for a few days or weeks in a dry atmosphere. The next operation is to press out the seeds from the berry on to a sheet of blotting paper, taking care to free them from mucilage. The seeds should then be dried either by pressing them lightly with another sheet of blotting paper or by exposing them to the atmosphere for an hour or two. When dry, the seed should be placed in a small envelope which bears on the outside the correct description of the origin of the berry. It is also advisable to keep the record of each berry in a notebook. The number of seeds in a ripe berry varies; the usual is from 50 to 200, but sometimes there is none and occasionally there may be as many as 400.

The seed should be sown in March under glass in a good sandy mould which may either be in boxes or in small pots of about two inches in diameter at the top. The seed should be sown one-eighth inch deep and covered over with sand. If boxes are used, the seed may be sown one inch apart in rows distant from each other three inches; if pots, then one seed to each pot. When the young plants appear above the soil they should be kept away from the direct sunlight to prevent their becoming "spindly" or getting scorched. About the middle of June they are ready for transplanting to the open border. (If the operation is practicable, the plants should be put into larger pots of about four inches in diameter in May.) When they get their second pair of leaves they should get more air, and be kept as near the glass as possible in a temperature of 45° to 50° at night and 60° to 70° during the day. When 2 to 3 inches tall they should be removed to frames outside to harden off, great care being take to protect from frost at night, as seedling potato plants are most tender. Later, when the plants are well established, they should be transferred to the open border.

At this stage it may be possible to eliminate plants which are already throwing a number of non-tuber bearing stolons, or are producing coloured tubers. The drills in the borders should be 2½ feet apart and there should be 2 feet between the plants in the drill. It is not absolutely necessary to sow the seed under glass, but seed sown in the open takes a long time to germinate, and at the end of the season the resulting plants are not large enough to permit of judgment on their merits, and cannot be subjected to the selective process until they have been grown for another season. As the seedlings grow they should be cultivated like ordinary potatoes, and careful notes should be made of the habit of growth, so that undesirable types can be discarded. The date of maturity, and, if possible, the rate of bulking of the tubers, should alse be noted.

At lifting time each plant should be lifted separately, and the greatest care must be taken to ensure that the crop collected from each root belongs entirely to that root, and that no tubers from adjacent seedlings are included. Only those which approach a desired standard should be retained. The produce of each selected plant should be kept in a separate small open box with an appropriate number and reference; and the produce of each variety should be kept separate, year after year, until the variety is discarded or distributed.

It is not always possible to decide on the merits of a seedling in the first two or three years, but by the end of the fifth year its real worth should be apparent. It may take a little longer to adjudge the cooking quality, which often improves every year in a young variety.

A promising seedling, grown as described above, may yield in its first year a crop comparable with that of a plant of a standard variety grown from a tuber in the ordinary way. Raisers are warned against the practice of forcing new varieties in their early stages by the "express culture" method, which consists of striking a succession of cuttings from each eye of the tuber, or any other practice which is calculated to impair the vitality of a new variety.

III.—How Old Varieties may appear as New.

It must be emphasised that every year the seedlings should be planted on ground absolutely free from potatoes. Raisers of seedling potatoes are, therefore, strongly recommended not to plant seedlings on ground where there have been potatoes during the previous five years.

Groundkeepers, *i.e.* small tubers left in the ground from a previous crop, are, without doubt, frequently mistaken for seedlings when they come up amongst the latter. This accounts partially for the regular annual appearance of old standard varieties under a new name and described as seedlings.

IV.—Yielding Capacity.

The yielding capacity of a variety is very difficult to evaluate, but considerable help is given if the variety can be compared with a standard type of its own class in point of its time of maturing. Suitable types to use for comparison are:—

First early . . .	Duke of York and Epicure.
Second early . .	British Queen.
Early maincrop . .	Abundance and Great Scot.
Late maincrop . .	Up-to-date and Arran Chief.

A few plants of each of the above should be grown under exactly the same conditions as the seedlings, and the yields per plant accurately compared; from this comparison the breeder can have a fair idea of the cropping powers of his seedlings.

The Board of Agriculture for Scotland intend to inaugurate a scheme for the comparative testing of new varieties and for the subsequent registration of those of outstanding merit. When this scheme is in full operation, any difficulty hitherto experienced by breeders in securing the profitable exploitation of the results of their experiments may be obviated.

V.—The Fertilisation of Varieties which seldom Bloom.

While the breeder will probably have in the flowering varieties sufficient suitable material to work upon, yet he may wish to make a cross on a variety which very seldom blooms. Various devices have been tried to induce plants of such varieties to bear flowers, but generally without success. Such devices include the breaking over or partial cutting of a stem of the plant, the prevention of the formation of tubers, propagation from cuttings, grafting and other operations calculated to create a tendency in the plant to develop its capacity for reproduction by means of the floral parts.

Fortunately, however, the parental potentialities of these types need not be lost if use is made of the "bolters" which occur in most varieties. A "bolter" is a plant which produces flowers, and perhaps self-set berries, much in excess of the normal plants of the type. "Bolters" differ physiologically from their more staid companions, and might almost be considered as rogues (a rogue being a plant of an alien variety). They have, in addition to their flowers, taller stems with longer internodes, generally smaller and more rigid leaflets, and are decidedly later in maturing. The varieties which have been known to produce "bolters" are indicated in the leaflet, "The Maintenance of Pure Stocks of Immune Varieties of the Potato." Tubers from "bolters" have been collected in the last three years, and in every case they have come true when propagated vegetatively (*i.e.*, by the tuber). With regard to the use for breeding purposes of "bolters," the following general statements may be made:—

(1) If the normal plants flower fairly freely, the "bolters," in addition to blooming profusely, will also produce natural berries. Examples are "Eclipse," "Edzell Blue," "Ally" and "Snowdrop"—all of which varieties

are known to set natural berries on "bolters." Conspicuous exceptions are "Up-to-Date" and "King George V."; their "bolters" never set berries naturally, but they are suitable as mother plants for cross-fertilisation work. The pollen of "Up-to-Date" has been shown to be markedly defective.

(2) If the variety very seldom flowers its "bolters" will flower, but will not produce self-set berries. Examples are "Evergood," "Great Scot," "Arran Chief," "King Edward," "K. of K.," on all of which varieties crosses have been effected. Varieties in the former class (1) can be utilised either for the production of natural berries or as a source of pollen for the cross-fertilisation of other varieties. Varieties in the latter class (2) can safely be used as maternal plants without emasculation: their anthers will most probably be defective.

VI.—VIABILITY OF THE POLLEN.

Considerable assistance is afforded to the potato breeder by the fact that if the anthers are pulled the pollen in them will retain its viability for some days provided they are kept in a suitable airy receptacle, such as a small tube plugged with cotton-wool or an empty match-box. In this way the choice of pollen parents can be greatly extended.

VII.—CHOICE OF PARENTS.

Very little information is available as a guide to the choice of parents, but there are distinct indications from experiments already carried out that the chance of obtaining an immune variety is greatest where two immune varieties are mated together, is less when an immune is mated with a non-immune, and still less in a cross between two non-immunes. Further, the percentage of seedlings which are immune in a batch of seedlings grown from the seed of a natural berry of an immune variety is greater than that in natural seedlings from a non-immune variety.

It may also be stated that the chances of obtaining a variety having white tubers are greatest when both parents have white-skinned tubers.

Apart from the above remarks nothing further of importance can be stated with certainty. The breeder must rely on his own observations and experience. Scientific potato breeding is still in its infancy. Progress can be made only by hard work, continued study and the pooling of information. A really first-class popular potato is not readily obtained; the work of raising new varieties has not been found remunerative in itself by most people who have attempted it. That, however, should not deter further effort. The need for new varieties of the right kind is urgent, and, apart from the possibilities of success, potato-breeding is a hobby of enduring and never-failing interest.

Note: References—

1. "Inheritance of Colour and Other Characters in the Potato," by R. N. Salaman, M.A., M.D. (*Journal Genetics*, Vol. I. [1910–11]).
2. "Lecture on the Hereditary Characters in the Potato," by R. N. Salaman, M.A., M.D. (*Journal Royal Horticultural Society*, Vol. XXXVIII. [1912–13]).
3. "The Inheritance of an Abnormal Haulm Type," by R. N. Salaman, M.A., M.D., and J. W. Losley, M.A. (*Journal Genetics*, Vol. X., No. 1. [1920]).

VIII.—SELECTION OF SEEDLINGS.

(a) *Tuber.*

Shape.—Tubers must be symmetrical in shape. They should be round, oval, oblong or kidney. The ideal shape of a commercial potato is the slightly flattened oval of "Up-to-Date" and "Sutton's Abundance," or the kidney types illustrated by "King Edward VII." and "Duke of York." The dimensional ratio of the ideal potato is approximately—

Length.	Breadth.	Thickness.
4 inches.	2·7 inches.	2 inches.

Varieties which have elongated and irregular shapes, or are decidedly pointed at the rose end, should be discarded, as should varieties which in an ordinary season show a tendency to lose shape on account of second growth.

Tubers should have a relatively small number of clearly defined but not deep eyes, and must have no deep indentations at the heel end, or at the rose end, or at any other point on the outside of the tuber. They should also be devoid of swellings about the eyes, and should have no other defect which spoils the symmetry.

(b) *Skin Colour.*

Skin colour should be white, yellow or russet. Pink splashes or streaks of colour are generally not considered objectionable. Varieties which have a complete flush of colour, which deepens on exposure to light, are generally to be avoided, while colours of red, blue and purple are to be considered as greatly detracting from the value of a variety. This objection is particularly applicable to late varieties in which a deep colour of the tuber renders gathering of the crop more difficult in late autumn. Pink colour is not so objectionable in early varieties, but nevertheless in this class also the demand is for white tubers.

The attractiveness of the tubers of maincrop varieties is enhanced by a rough or netted appearance of the skin. This condition is due chiefly to environment, but is to a certain extent varietal.

(c) *Flesh.*

The flesh of potato tubers should be of a white or light lemon colour. It should be firm throughout. Yellow fleshed varieties are generally unmarketable in this country, except in the case of first early varieties. Any varieties which have a tendency to form streaks of red or blue colour in the flesh are of no value. When sprain or hollowness in the centre of tubers appears frequently, the variety should be discarded. Varieties used for culinary purposes in their season should boil white and remain white for some time after cooking.

(d) *Underground System.*

A profusion of fibrous roots denotes the uselessness of the variety which produces them. This condition is generally associated with an abundance of long runners, which is another indication that the variety is valueless. Any propensity towards the formation of second growth in a normal season detracts from the worth of a variety, whether the second growth takes the form of—

(*a*) Shoots from the eyes, with or without secondary tubers;
(*b*) Tubers growing on the rose end of the first formed tuber;
(*c*) Bulbous outgrowths above the eyes or protrusion of the eyes;
(*d*) "Lady-waisted" tubers;
(*e*) Super tuberation, *i.e.*, the tendency to form tubers above soil, generally as a result of injury, disease or defective cultivation; or
(*f*) Cracking and hollowness in the tuber.

(e) *Number of Tubers to the Plant.*

Varieties must be able to yield a heavy crop. A new variety cannot have much chance of success unless it is able to yield from two to three pounds of tubers per plant in average good soil in drills 30 inches wide, with the plants 1 foot 6 inches apart. There must be a preponderence of ware tubers, 4 to 7 ounces. The presence of large numbers of chats, or of large numbers of tubers of seed size (2½ to 3 ounces) in the crop, indicates that the variety is of little worth for commercial purposes. The tubers should be borne at the end of short runners and fairly close to the bottom of the stem; long runners, which strike through to the outside of the drill, disqualify a variety from further consideration. First and second earlies should show a marked tendency to grow fast and to bulk early.

(f) *The Haulm.*

The ideal haulm consists of a few strong, upright, vigorous stems, not too tall, with short internodes, forming an abundance of spreading foliage which gives a good cover. The leaflets should be free from any tendency to curl. The haulm should not be woody or wild, and should, even in the case of late varieties, die off before the usual time of lifting. Very late varieties, on account of their late maturity, are not to be recommended, being liable to be destroyed by frost before the haulms have died down sufficiently to permit of the crop being lifted.

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Varieties which produce berries in profusion should be viewed with disfavour.

It is noteworthy that the rank strong-growing late-maturing type of haulm is generally associated with a profusion of fibrous roots and an abundance of long runners; it is not, as some people believe, an indication of great cropping capacity.

(g) *Varieties for Special Purposes.*

It is hardly possible to combine all desirable qualities in any one variety. Some sorts are markedly deficient in some respects, yet have characteristics which make them specially suitable for some branches of the potato trade. For instance take "Epicure," which bulks very early and has a hardy and vigorous haulm, and "Golden Wonder" which keeps very well and is of superior table quality. These varieties are popular despite the facts that "Epicure" has a coarse tuber of only moderate table quality and that "Golden Wonder" generally yields a small crop.

IX.—WART DISEASE AND IMMUNITY TESTS.

No new variety is likely to be a commercial success unless it is immune from Wart Disease. The Board offer facilities for the testing of new varieties with regard to their susceptibility to or immunity from this disease, and these facilities are such that no breeder need accumulate a large stock of any variety which will be ultimately discarded as non-immune.

Raisers of new varieties must, however, exercise discrimination in submitting varieties for test.

It is wise to reject immediately varieties which show a rank and wild condition—evidence of which is the production of many thin stems or stems branching freely above ground, associated with a tendency to produce matted roots, long runners, much second growth and coarse ungainly tubers—as well as varieties which have tubers with coloured skin or coloured flesh.

It is also futile to hope to procure an immune variety by selecting tubers from a variety known to be susceptible. Persons who continue to cultivate varieties which have obviously objectionable features or which have now been proved definitely and absolutely susceptible are wasting their own time in so doing and the public time in submitting such varieties for test.

Varieties of Oats.

THE following account of oat-growing experiments in North Wales has been extracted from a bulletin issued by the Department of Agriculture of the University College of North Wales, Bangor:—

1921 Trials.—In 1921 sixteen varieties of oats were grown in the lower part of Cae Brisdir. The soil is a rather heavy loam, and was cropped with roots in the previous year. Sowing took place on April 20th and 21st, the land was in good tilth, and germination on all the plots was even and good. Two series of plots were laid down, each being a narrow strip one-sixth of an acre in size, extending right across the field. In this way it was hoped to reduce the effect of any slight variations in the soil, and the general agreement between the results from the two series of plots shows that this aim was to a large extent realised. On the whole the yields in Series I. were lower than those in Series II., but the order of the varieties in the two cases was very similar. As in the two previous years, an attempt was made to sow the same number of seeds per acre for all varieties, and two and a half millions per acre was the number aimed at. In 1919, with a "force-feed" drill, the attempt was fairly successful, but in 1921 the result was not so satisfactory, owing largely to the substitution of a "cup" drill, which, while superior in some respects, does not allow of the same gradual adjustment of the rate of sowing.

The progress of the crops for some time was very good, but ultimately the long drought of 1921 produced its effect, particularly on the length of straw. The effects of the drought were particularly noticeable in the plots of Captain, Bountiful, Black Tartarian and Sir Douglas Haig in Series I., and in home-grown Record, Yielder and Leader in Series II. Captain and Sir Douglas Haig in the former, and Yielder in the latter series, were in parts affected to such an extent that shrivelling was noticeable by the middle of June, and this should be taken into account in considering the yields as shown in Table I.

The yield and quality of the grain were satisfactory, much more so than in 1920, as is shown by the generally higher proportion of kernel than in that year (*see* Table II.).

The weather conditions for cutting the corn were very good, and the various plots were dealt with, as they became ripe, from August 3rd to August 15th. Very little loss was caused by lodging or shedding of corn, though, owing to dull, heavy weather after cutting, the plots could not be carted until August 30th and 31st. On those days they were carted and threshed immediately. The whole crop was weighed on the cart from each plot, the grain was weighed from the threshing machine, and the weight of straw and chaff calculated by taking the difference between the total weight and the weight of grain.

Table I. gives particulars of the yield of grain and straw in the two series of plots.

The following conclusions may be drawn from the average yields of the two series, taken along with observations made on the crop during the growing season.

On the whole the white varieties out-class the yellow and black varieties, the only exceptions being Yielder and Captain. The first positions were held, as in many previous years, by Record (new seed) and Victory. The yields of these two varieties were in 1921 also equalled by Crown. The consistently high positions of Record and Victory leave little doubt that these varieties are two of the White Oats best suited for cultivation on good lowland in North Wales. The season of 1921 did not afford an opportunity of comparing strengths of straw, but observations made in previous years indicate that the straw of Record is stronger than that of Victory, and this should be taken into account in deciding which of the two varieties to grow.

TABLE I.

SERIES I.		VARIETY.	SERIES II.		Estimated value of head grain per quarter (336 lb.) in October 1921.
Yield of grain per acre.	Straw and Chaff per acre.		Yield of grain per acre.	Straw and Chaff per acre.	
Bushels (42 lb.).	cwt.		Bushels. (42 lb.)	Cwt.	
		White:			
64	18¼	Record (Home-grown)	64	20	24/-
69	22½	Record (New) . .	77½	21¼	24/6
53½	20½	Yielder . . .	61¾	26¼	24/-
65¾	18½	Abundance . . .	64½	26	26 -
64¼	19¾	Leader . . .	73	23	23/6
54½	19¼	Captain . . .	60½	24½	23/-
68	23	Victory . . .	77¾	26	25/-
69	20¾	Crown . . .	76	25	24/
59½	21½	Beseler's Prolific . .	65¼	25½	26/-
55½	22	Wide Awake . .	67¼	24¼	24/-
...	...	Waterloo . . .	63	20¼	21/-
		Yellow:			
56¾	20¾	Golden Rain . .	63½	25¼	25/-
55¾	19½	Goldfinder . . .	60¼	22	25/-
57¾	15¾	Yellow Naasgard. .	62	18	24/6
		Black:			
50¼	22	Bountiful . . .	48½	22¼	23/-
58	20¾	Black Tartarian . .	58	19½	22/6
58	19½	Sir Douglas Haig .	60	24¼	22/-

Of the new varieties, Sir Douglas Haig has given the best yield of the Black Oats, and Yellow Naasgard compares favourably with the other Yellow Oats. Waterloo is a Canadian variety, which, on account of the low quality of the grain, is not likely to prove of any particular value as a grain producer in this country, though it may possibly find a place in exceptional cases for other purposes.

The exceptionally low yield of Bountiful last year was anticipated before harvest, as the ears ripened prematurely, while the stems were still green. This variety is used both for Autumn and Spring sowing, and it is possible that the seed obtained was a winter form, not suited for Spring sowing in such an abnormally dry season. Usually Bountiful has compared very favourably with other black varieties

Proportion of Kernel to Husk.—An estimation of the proportion of kernel to husk was made in each variety from samples drawn both from seed put down in Spring and from grain harvested in the Autumn of 1921. As in 1919, husk and kernel were separated in 300 grains in each case, and weighed. The last columns are the more likely to represent the real character of the varieties, as those samples were grown and thrashed under identical conditions at Aber, while the grain sown in Spring was drawn from several different sources.

It is rather surprising to find that the proportion of kernel was on the whole much higher in the 1921 crop than in the 1919 crop, as although the summer of 1919 was very dry and unfavourable to the growth of oats, the drought of 1921 was, of course, much more severe. The explanation is probably to be found in the conditions during Spring. The Spring of 1919 was very unfavourable, and it was only with great difficulty that the soil could be got into condition for sowing by May 6th. Before the young crop had had an opportunity of establishing itself, the drought of June checked its growth. In 1921 the Spring was more favourable, and the oats were sown with the soil in nice condition on April 20th and 21st. Conditions for some time were favourable, and the crop had a good start.

TABLE II.

Seed sown in Spring, 1921.		VARIETY.	Crop harvested in Autumn.		
				Kernel.	
Husk.	Kernel.		Husk.	1919.	1921.
1	...	Record (Home-grown) . .	1	2·06	2·67
1	2·80	Record (New)	1	2·44	2·85
1	2·72	Yielder	1	2·20	2·33
1	3·11	Abundance	1	...	3·37
1	3·37	Leader	1	1·98	2·62
1	2·56	Captain	1	1·77	2·74
1	3·00	Victory	1	2·87	2·85
1	2·64	Crown	1	...	3·11
1	3·06	Beseler's Prolific . . .	1	2·37	2·66
1	3·15	Wide Awake	1	1·89	2·33
1	1·69	Waterloo	1	..	2·72
1	2·68	Golden Rain	1	2·74	2·98
1	3·31	Goldfinder	1	2·10	3·18
1	2·78	Yellow Naasgard . . .	1	...	2·85
1	2·47	Bountiful	1	1·51	2·68
1	2·52	Black Tartarian	1	1·59	2·07
1	3·15	Sir Douglas Haig . . .	1	..	2·46

Earliness of Ripening.—Observations were also made on the earliness of ripening of the varieties. A variety was reckoned ripe when the last tinge of green was about to fade from the chaff. Table III. gives the results for the three years 1919, 1920 and 1921.

It will be noticed that in 1921 the period of growth varied from 103 to 117 days. In the wet summer of 1920 the period varied from 127 to 143, while in the more normal year of 1919 the range was intermediate—107 to 130 days. Taking the three years together, Captain, Golden Rain and Yielder have held leading place as regards earliness of ripening.

It is important to note that in the fairly normal season of 1919 the differences in ripening between the varieties were more marked than in the exceptional years of 1920 and 1921. In North Wales, where harvests are often late and wet, earliness of ripening is an important point. A difference of two or three weeks in ripening often makes all the difference between a spoilt crop and one harvested in good condition. For instance, Golden Rain and Goldfinder are on the whole very similar in cropping powers, quality of grain and other qualities, except earliness of ripening. In many seasons the former could be safely harvested before the latter was ready for cutting.

TABLE III.

1919.		1920.		1921.	
Classification of varieties in order of ripening.	Days from sowing to ripening.	Classification of varieties in order of ripening.	Days from sowing to ripening.	Classification of varieties in order of ripening.	Days from sowing to ripening.
Captain	107	Yielder	127	Captain	103
Record (Home-grown)	112	Golden Rain	128	Golden Rain	105
Record (New)	112	Captain	128	Yielder	106
Beseler's Prolific	113	Tartar King	129	Record (New)	107
Golden Rain	114	Record (New)	131	Abundance	108
Yielder	115	Record (Home-grown)	131	Victory	109
Tartar King	115	Wide Awake	132	Crown	109
Leader	117	Hero	134	Bountiful	110
Wide Awake	118	Leader	134	Beseler's Prolific	111
Hero	118	Victory (Home-grown)	135	Wide Awake	111
Supreme	119	Supreme	136	Leader	112
Bountiful	120	Douglas Haig	137	Waterloo	114
Black Tartarian	121	Beseler's Prolific	138	Douglas Haig	114
Goldfinder	122	Victory (New)	138	Record (Home-grown)	114
Victory	122	Bountiful	140	Yellow Naasgard	115
Du Bach	123	Guinea Gold	140	Goldfinder	115
Black Mogul	125	Yellow Poland	141	Black Tartarian	117
Potato	130	Goldfinder	143		

Plant Improvement in Belgium.

THE Experiment Station for the Improvement of Agricultural Plants, attached to the Gembloux Agricultural Institute, carries out its programme of work on the following main lines:—

I.—Experimental selection, and crossing combined with selection.

II.—Culture tests of the new types thus obtained in the different agricultural regions of the country, with the object of testing their practical value as regards the local agrogeological and climatic conditions (Regional Research Centres).

III.—Enquiries as to the value of the principal varieties now cultivated in Belgium.

SELECTION—*Cereals.*—The work of selection is carried out as follows:—From among the descendants of one parent plant those individuals are chosen that possess to the greatest extent the characters to be preserved. The group of individuals thus isolated forms "first choice," while the rest are the "second choice." The following year, the offspring of the "*first choice*" are also divided into *first choice* and "*second choice*," and the seed of the best individuals of the latter serve for the "first multiplication." The best specimens thus obtained are used in their turn for subsequent "multiplications," whereas the descendants of the "first choice" continue to be divided into "*first choice*" and "*second choice.*"

The yields of the selected plants, as well as those of the "multiplications," are analysed with great care, special attention being paid to characters that affect productivity (number of seeds per plant, weight of 100 or 1000 caryopses, per cent. of seeds yield per *are* etc.). These details, in addition to the continual careful observations made during the growing season with the object of studying the resistance of the plants to cold, disease and lodging, their early ripening, etc., furnish data for the subsequent discarding of the inferior plants, and the isolation of the best.

The improvement of wheat and oats was begun in 1913–1914, and, in 1919–1920, there were 103 pure lines of wheat and 77 of oats being studied. In 1919, the work of improving spelt and winter barley was commenced; 202 parent spelt plants and 172 of barley were examined comparatively.

The parent plants were chosen from plots sown with the seed of varieties from different districts; the examination of the plots will at once show that these varieties are far from being homogeneous, and should rather be regarded as associations of numerous varied forms, many of which are distinguished from one another by constant and well-defined characters.

The Station proposes to separate these associations by isolating pure lines and propagating the best types. Much has already been done in this direction, especially in the case of wheat. Large and complicated crossing experiments are also being carried out with the latter. Crosses between several varieties of wheat have been made since 1918, and repeated in the following years, in order to obtain types with a higher yield, but at the same time resistant to cold and maturing early.

In 1919, some pure lines of wheat showed "speltoid" mutations, which were isolated, and have now reached the third generation.

Potatoes.—At present eighty-one lines are being studied, especially as regards high starch content, resistance to disease, cooking properties and yield. Some already show a good combination of these characters.

Sugar Beets.—In 1915, a "first choice" was made of 100 plants which were selected for shape, weight and the high sugar content of the root. Then alternate generations of the seed-beets and the roots of the best lines were kept. Little work has, however, been done, on account of lack of men.

REGIONAL RESEARCH CENTRES.—In 1919, the advisability was discussed of creating branch stations, or phytotechnical stations of secondary importance, for the different agricultural regions of Belgium. Three such stations have already been established, at Brosbeke (East Flanders), Clavier (Condroz) and Carlsbourg (Ardennes). The duties of these stations are:—

(1) To study the behaviour, in different soils and climates, of the varieties obtained at the Central Station;

(2) To compare these varieties with the best local varieties ;
(3) To try to introduce and acclimatise foreign varieties, especially those coming from N. Holland, or obtained at Svalöf.

ENQUIRIES.—In 1919–1920, at the request of the Central Station, and under the auspices of the State Agriculturists, a census was taken of the varieties of cereals cultivated in Belgium.

The station keeps constantly in touch with foreign scientific work connected with the genetics and improvement of agricultural plants. All the principal journals dealing with genetics, and the best works that have hitherto been written on the subject of heredity can be consulted at the station.

In order to facilitate research, all the data have been entered systematically on a card-index.

Galloway Cattle in the Highlands.

WITH a view to ascertaining whether cattle of the Galloway breed would thrive entirely out-of-doors in the Highland districts, the Board arranged in 1918 for eight six-quarter-old black Galloway heifers to be accommodated at the farm of Keilator, Crianlarich, north-west Perthshire. The farm is an ordinary hill sheep farm, practically none of the land being lower than 600 feet above sea-level, and rises abruptly to over 3,000 feet. There is very little arable land. The cattle were never allowed on the low ground, and were seldom on land below 1,000 feet. The grazing land was rough hill pasture, where there is no shelter except that afforded by rocks and ravines.

The cattle selected for the experiment were fully pedigreed, seven being well developed strong-coated animals, and the eighth rather smaller, less robust, and with a distinctly softer coat. The animals arrived at Keilator in September 1918, and throve well until the end of December, the weather during this period being mild, except for one spell of very hard frost. From the beginning of January they received a daily ration of four to five lb. of baled hay which was fed on the hill-side. This extra feeding was continued until the end of April, when the cattle appeared to obtain all the food they required, as they no longer looked for the extra rations. The weather during this period had been very severe, and while the cattle had naturally lost condition, they had grown in size, and rapidly recovered when grass was plentiful.

In July 1919, the heifers were mated to a white shorthorn bull which was turned loose on the hills, and it was subsequently found that all the animals were in calf.

The winter of 1919–20 was severe, and snow lay on the ground for considerable periods. The daily ration again started in January 1920, and consisted of five to six lb. of oat-straw and two lb. of undecorticated cotton cake. The heifers lost a little in condition during the first three months of the year, but recovered by the time they calved in May. Seven live calves and one dead one were born, and the heifers gained condition while suckling the calves. A bull was turned loose with the cows again in July, but apparently only two came in season, or held to service, as only two calves were born in May 1921.

The ration given in the winter of 1920–21 was slightly increased—six to eight lb. of oat-straw and two lb. of cotton cake, with an addition during the months of February and March of some stack-made silage.

During the progress of the experiment, seven out of the eight animals grew well, and after their third year developed into beasts of normal "Galloway" size and weight for their age. They are remarkable for their activity and healthy appearance.

It would appear as the result of this experiment that Galloway cattle of sound constitution can thrive entirely in the open in such a climate as north-west Perthshire, supported by a comparatively small ration. Perhaps, however, an undue proportion of such a stock would be liable to be farrow in alternate years, but the numbers experimented with are rather small to justify a definite conclusion.

In the winter and spring of 1919–20 a number of in-calf Highland heifers grazed with the Galloway heifers, and were not in such good condition as the Galloways until the spring was far advanced; but shortly before calving the latter seemed to lose condition more than the former. When the grass appeared, however, both lots gained condition rapidly.

The experiment tends to show that, provided a moderate quantity of cheap winter keep is available, Galloway cattle can be kept on high exposed situations without suffering from the climate. In such conditions they can produce Blue-Grey calves to a Shorthorn bull, and these calves are more valuable than cross or pure-bred Highland or pure-bred Galloway calves. The problem is one of winter keep. Throughout the Highlands and southern uplands summer grazing may be said to be cheap and abundant. Wherever meadow hay or silage can be made so as to supply four to five lb. of the former or ten to fifteen lb. of the latter per day for three winter months in the Highlands, these cattle can be wintered on the hills.

It should be emphasised that the farm of Keilator is situated at an exceptionally high altitude and is bare of shelter. The cattle were placed, therefore, under a very severe test.

The Fertility of Twins and the Free-martin in Cattle.

THE following communication has been received from Mr F. A. E. Crew, M.D., D.Sc., Director of the Animal Breeding Research Station, Edinburgh.

The frequency with which the question is asked as to the fertility of twins in cattle indicates that the exact significance of the free-martin is not clearly understood by breeders generally.

Recent work by Lillie, Chapin and Minoura in America, and by Magnusson, Tandler and Keller in Germany has removed all doubts as to the general cause of this remarkable phenomenon and has furnished a very pleasing example of the manner in which science can reinforce the art of animal breeding.

These workers have been able to furnish a complete answer to a problem which interested the Romans and which has engaged the attention of such investigators as Spiegelberg, Neuman, *J.* Y. Simpson, Berry Hart, Bateson and Cole, who, because of limited material and less critical methods of examination, were unable to find its solution.

Twins in cattle may be both males, both females, or one male and the other female, and perfectly normal in every way. But it happens that in a certain number of cases one twin is a perfectly normal bull, while its co-twin is what is known as a free-martin, having an abnormal reproductive system and being sterile. The abnormality varies in its degree but though both the internal and external genital organs may appear to be an intimate mixture of male and female parts, usually the external genitals approach the female pattern and the internal the male pattern in form and arrangement.

Now, twins in cattle, as in other forms of animal life, may arise from the fertilisation of one and the same egg by two sperms, or on the other hand, from the fertilisation of two eggs by separate sperms simultaneously. In the first case, if two individuals arise from one egg, this having been fertilised by two sperms, then the two have sprung indeed from one beginning: they will be of the same sex, closely resembling one another, and are, therefore, known as identical twins. In the second case, when each of the twins has resulted from the union of an egg and a sperm, then each is a distinct individual; such twins do not resemble each other at all closely as a rule, are as often as not of opposite sexes, and are spoken of as fraternal twins.

The earlier workers formed their conclusions as to whether the twins were identical or fraternal upon the presence of one or of two chorions (the bag which contains the unborn calf and which comes away as the afterbirth). But it has been shown conclusively that as a rule, even if there are two separate chorions in the early stages of development, they fuse later and appear to be but one. Fortunately there is an infallible test as to the nature of twins, and it is a simple matter to decide whether they have arisen from one egg or from two. The mature egg is discharged from the surface of the ovary and an open wound is thus left. This, like any other wound, heals but the scar-tissue is peculiar in that it is of a yellow colour and serves a most important function. This *corpus luteum*, this mass of yellow cells, produces a secretion which passes into the blood-stream and controls the development of the organs which are concerned in the nutrition of the unborn offspring and of the mammary glands which furnish the young with milk.

The number of these *corpora lutea*, therefore, will indicate the number of eggs which have been discharged from the ovaries and fertilised. It has been shown conclusively that in all cases in which one twin is a free-martin, the twins are fraternal, for two *corpora lutea* are invariably found. This is also supported by the fact that in coat-colour and general characters a free-martin resembles its co-twin only to the extent that a fraternal twin should and no more; whereas, if the free-martin were an identical twin, and therefore a male (since the normal co-twin to a free-martin is invariably a bull-calf), it should almost exactly resemble its co-twin in respect of these characters.

But fraternal twins may be of the same sex, both male or both female, or one may be a male and the other a female. As they are quite distinct individuals there is no reason why they should be of the same sex. So that the question had to be answered as to whether the free-martin co-twin to a normal male was an imperfect male or an abnormal female.

Of all the calves that are born there is on an average one male to one female, so that in the case of twins there should be twice as many cases in which the calves are of opposite sexes as cases in which they are both male or both female. If the free-martin is regarded as an imperfect male, then when the total number of calves including these cases is considered, the number of males is out of all proportion to the number of females, whereas if they are regarded as abnormal females the resulting total number of females is more or less equal to the number of males, which is as it should be. This fact, supported by the very logical assumption that there can exist no conceivable reason why the association in the calf-bed of two males should lead to the transformation of one of them into a free-martin, makes it certain that the free-martin is a malformed female co-twin to a male. A study of the genital organs during their development thoroughly corroborates this view.

The task which Lillie had now to face was that of demonstrating the mechanism of the process which resulted in the production of the free-martin. He succeeded in the most brilliant manner.

The two fertilised eggs start their development in opposite horns of the uterus of the mother, but as they increase in size they ultimately meet in the body of the uterus with the result that in the majority of cases their chorions fuse. This happens when the embryos are about 15 mms. long. But each chorion is very richly supplied with blood-vessels and if the two meet, these vessels, especially the arteries, develop in such a way that they communicate with each other by minute branches. The result is that the blood of each embryo passes through the body of the other and there is a constant interchange of blood between the two up to the time of their birth.

This interchange of blood by twins (or by triplets, or even by more) occurs only in those cases in which the chorions of the different embryos fuse. This fusion does not occur in sheep; it occurs commonly in cattle and there is reason to believe that it happens also in the cat. It has been conclusively proved that the free-martin results only when the chorion of a female and of a male embryo fuse in this way. If it happens that this fusion and the consequent interchange of blood do not take place then the female co-twin to a male calf is a perfect fertile heifer, as is the case in one-eighth of cases of bull and heifer twins. So that the agents responsible for the transformation of a female into a free-martin must pass into its body from the body of its male co-twin by the blood stream.

In a way blood may be regarded as the essence of the individual. Along its stream are borne the products of the glands of internal secretion, the action of which regulates the activities of the various functions of the body. The testicle of the male and the ovary of the female furnish secretions and these are known as the *sex-hormones*, a hormone being the messenger, chemical in nature, which arouses distant parts to further activity.

Up to a certain stage of development there are no structural evidences of the determined sex, for there exists, prior to this stage, merely a common plan of architecture and it is quite impossible to tell whether the embryo is to develop into a male or into a female. But soon the sex-glands begin to produce their internal secretion and under its direction the glands take on the form of ovaries or of testicles, as the case may be; the other parts of the reproductive system conform in their development so that the female or male arrangement respectively results, whilst the external characters likewise conform to the female or to the male type. Sex itself is determined at the time when sperm meets egg, but the development of the distinctive male or female pattern of reproductive system, sex differentiation, does not occur until the sex-hormone is produced.

There are reasons for holding that every embryo, under the direction of the appropriate hormone, can come to be equipped with the reproductive system of either male or female pattern, for the differences between the two are nothing more than differences in the degree and direction of development of structures possessed by every embryo: the common type of sex-gland becomes either ovary or testicle; the external parts become either the scrotum or the lips of the vulva, and so on. The mode of development of these structures is directed by the action of the sex-hormone, male or female, as the case may be.

Now, it so happens that the sex-hormone of the male, the internal secretion of the testis, is produced before the sex-hormone of the female, the internal secretion of the ovary. That is, the undifferentiated immature sex-gland which is destined to become a testicle produces the male sex-hormone slightly earlier than the gland which is destined to become an ovary produces the female sex-hormone.

In the case of twins, therefore, one of which is destined to become a male and the other a female, and which are connected by a common blood supply, the sex-hormone of the male twin will be circulating in the bodies of both before the internal secretion of the ovaries, the sex-hormone of the female, has appeared.

So that if the male-hormone from the male-twin circulates in the body of the female, in whom the internal secretion of the ovaries has not yet appeared, the undifferentiated sex-apparatus will naturally develop according to the male plan.

The result is that the female twin will be transformed into an individual which possess a more or less complete organisation of the male. The sex-glands will develop into more or less perfect testicles, and the other parts of the reproductive system will be also more or less completely male in type. The fœtuses examined by Lillie provided a graded series from the almost perfect female to the nearly complete male, and the differences in the degree of transformation can be explained by differences in the time of onset, intensity and duration of action of the sex-hormone of the male. The external genital organs are the least liable to modification, and in the majority of free-martins these are of the female type, though more or less imperfect.

The contention that the transformation is due to the action of the internal secretion of the sex-glands is endorsed by the fact that the reproductive system is the only part of the body affected, and it is acknowledged that the development of this system is controlled by the internal secretion of the sex-glands, a fact which is also illustrated by the results of castration.

Since the sex-glands of the female twin are so affected by the internal secretion of the testes of the other, the female sex-hormone is never produced, and there is no struggle for mastery between it and that of the male.

The specimens examined by Lillie were all fœtuses removed from the uteri of pregnant cows. This means that the process of transformation of a female calf into one with the male organisation was cut short by the death of the mother. The fœtus at the time of the examination was a free-martin in these cases. Further, it is known that the free-martins are born at term. But the degree of the transformation towards the male type depends upon such conditions as the duration and intensity of the action of the sex-hormone. Theoretically, therefore, there is reason to believe that in some cases the result will be that what appears to be (at all events) a normal fertile male is born, and there is nothing remarkable in the birth of twin bull-calves. But in these cases one is not a male really, it is a masculinised female. It possesses the male organisation, looks like and behaves like a bull, actually fertilises the eggs of a heifer, but nevertheless it is a female. Its progeny will bear testimony to this, for every one will be a female. Its sex was determined in the union of the egg and sperm from which it sprang, but owing to the interference with its normal development by the sex-hormone of its mate it came to possess the sex-equipment of the opposite sex.

In the majority of cases the transformation is not so complete, and a typical free-martin results, having obvious abnormalities in structure and behaviour. In others the external genitals are normal in appearance, but the fact that the heifer does not experience periods of heat indicates that there is an abnormality of the internal genitals, the ovaries usually being much affected. In this way a free-martin can be distinguished from the female fraternal twin to a bull, which, owing to the fact that there was no interchange of blood, is perfectly normal and fertile. If the heifer is normal in appearance and behaviour and experiences periods of heat then she is not a free-martin; if she is normal in appearance but does not come on heat, and was born co-twin to a bull, then she is a free-martin and is abnormal internally, though quite perfect so far as the external genitals are concerned.

The tendency to produce twins is hereditary. Of the twins of opposite sexes the majority will include a free-martin. But it is doubtful if this is sufficient to warrant the eradication of twinning by careful selection. The free-martin is not a monstrous calf, the result of inherent abnormality: at the beginning of its existence it is perfectly normal; its abnormal development is moulded by extraneous circumstances over which the individual has no control. It cannot function as a female and bear offspring, so that the tendency to produce free-martins cannot be handed on to succeeding generations. The production of such individuals results from the tendency of the chorions in cattle to fuse, with the consequent development of blood-vessels communicating with both fœtuses.

The heifer co-twin to a bull which is structurally abnormal, or which does not experience periods of heat, should be fed for the butcher, but the one that is normal in structure, and which has bulling periods, should be retained within the herd. The free-martin is no bar-sinister in the history of any herd.

THE Board desire to draw attention to the following circular issued by the Meteorological Office.

Weather Forecasts for Farmers.

Notification of Spells of Settled Weather.—The Meteorological Office issue telegraphic notifications of occasions on which a spell of fair settled weather of several days' duration, is anticipated. Recipients of such notifications will be kept informed during the continuance of the spell, of the progress of meteorological events and warning of the break up of the spell will be sent as far in advance as possible. The following specimen telegrams indicate the scope of the service:—

1st Telegram:—Fair weather spell anticipated.

2nd Telegram (2 days later):—Conditions less settled perhaps some showers.

3rd Telegram (following day):—Break only temporary; fair weather expected to continue.

4th Telegram (2 days later):—Becoming unsettled, rain expected during night or to-morrow; spell terminated.

A fee of 6d. is charged for each telegram despatched in addition to the Post Office charges for telegraphy. A minimum sum of 7s. 6d. against which the charges may be booked must be deposited with the Office.

Daily Forecasts.—Regular forecasts are now issued at any time of the year and at the following hours: 10 *a.m.*, 3.30 *p.m. and* 8.30 *p.m. in winter, and* 10.30 *a.m.*, 4 *p.m. and* 9 *p.m. (Summer Time) in summer.* Forecasts issued at the morning hour refer to the period covering the afternoon of the day of issue and the morning of the following day. Those issued in the afternoon and evening refer to the whole of the following day. All the forecasts include a "Further Outlook" of the probable weather beyond the twenty-four hour period whenever such a further outlook can be given. If the conditions at any time indicate that a spell of several days fair weather is likely, a notification of this is included in the next regular telegram. But if the special form for "Spell Notifications" has been returned and the deposit paid, the notification is sent at the time without waiting for the next regular telegram. If the time coincides with that of a regular telegram, only the one telegram is sent. The notification fee is not in this case charged.

Transmission of Forecasts for Single Districts by Telegraph.—Daily forecasts for single districts can be sent by telegraph for periods of not less than six consecutive days to any address in the United Kingdom upon prepayment of a registration fee of one shilling, and the cost of telegraphy computed at one shilling and threepence (1/3) per message.

Notification of Special Conditions.—The Office will send, by telegraph, forecasts in anticipation of special conditions, such as spells of frost, ground frost, smooth sea, &c. If the time of sending the forecast be left to the discretion of the Office a fee of 2s. 6d. which includes the cost of the telegram is charged for this service.

Forms of application for forecasts under the above arrangement may be obtained from The Director, Meteorological Office, Air Ministry, Kingsway, London, W.C.2.

Applications by telegraph for single forecasts should be addressed to "Weather, London," and the reply should be prepaid.

Scottish Women's Rural Institutes.

THE case for Women' Institutes rests on their economic value as well as on their success as educational and social centres. Professor Bowley has recently shown that pre-war production was insufficient to ensure prosperity among the lower grades of workers, and it is generally recognised that a man on a small wage, with a wife who knows her work, is often better off than a man on a large wage whose wife knows nothing of keeping house. The part played by the housewife's wise utilisation of family resources in the cycle of national prosperity is difficult to measure statistically, since it involves a return not only in capital but in health, and therefore in increased capacity for production, but it may nevertheless form a determining factor in national well-being.

The movement throughout Scotland continues to show steady progress. There is a continuous demand for the formation of new Institutes and marked development of the work undertaken by the old. A comparison of the areas in November 1919 and November 1921 shows both the rate of progress in numbers and the distribution of Institutes.

Area.	November 1919.		November 1921.	
	No. of W. R. I.	No. of Members.	No. of W. R. I.	No. of Members.
North-West	18	601	30	1,352
North-East	16	871	45	3,037
Central	16	752	36	2,924
South-East	13	703	24	1,762
South-West	6	378	44	3,214
Total for Scotland . .	69	3,305	179	12,289

Numbers are, however, less important than development, and it is satisfactory to note that the percentage attendance at meetings ranges from seventy-one in the north-east to sixty-two in the south-east, and has risen from forty-seven to sixty-three in the north-west. Percentage attendance is a fair indication of sustained interest taken in meetings.

The organisation is now sufficiently large to profit by devolution, and area conferences will take the place this year of the central conference held hitherto. The conferences will take place in Aberdeen, Ayr, Ballachulish, Dingwall, Edinburgh and Perth, and will be attended as hitherto by two delegates from each Institute. In Dingwall and Perth the two days preceding the conference will be devoted to systematic study of the theory and practice of Institute work, and the Board has also been requested to arrange a more extended summer school for those members who are willing to undertake voluntary work in connection with the Institutes.

Organisation of classes in conjunction with the local Education Authority and the Colleges continues to form one of the most valuable sides of the Institutes' work.

The Women's Rural Institute Exhibit at the Highland and Agricultural Society's Show is to be merged this year in a Rural Industries Section, with special classes for the Scottish Women's Rural Institutes in the south-west area, to whose lot the organisation of an exhibit at Dumfries would have fallen.

Agriculture Conditions.

THE weather during December was mild and open in the great majority of the districts and cultivation was unusually well forward at the end of the year. During January the weather was variable and outdoor work was interrupted to a considerable extent. The early part of the month was wet and stormy, and towards the middle there was a heavy fall of snow that lasted for some days; during the last week the weather was drier, but in most cases the land was unworkable and comparatively little ploughing was done during the month. The conditions during February were generally unsuitable for farm work. In the north-eastern, central and eastern counties the greater part of the month was cold; frost, rain and snow alternated, and outdoor work was retarded owing to the heavy state of the soil. Towards the end of the month, however, conditions improved and some progress with ploughing was then made. The weather in the south-eastern counties was less severe, but outdoor work was practically confined to carting operations. In the western and south-western districts the rainfall was heavy and the seasonal operations were interrupted to a more or less considerable extent; from some districts it is reported that both carting and ploughing are somewhat in arrears. Taking the country as a whole, however, outdoor work is fairly well forward and with drier weather any arrears will soon be overtaken.

The wheat crop has progressed fairly satisfactorily and, except on wet land, the plant is of good colour and is vigorous and healthy. In south-west Forfar, Roxburgh and north Ayr, however, growth has been slow, while in Dumbarton the braird is rather irregular. No reliable estimates are yet available, but it is expected that the area sown this year will not differ to an appreciable extent from that sown last year.

The condition of last year's potato crop is generally about the average. In the Lothians and Dumfries, early varieties and some late varieties are stated to be growing in the pits, but the tubers so far are mostly sound. Damage from sprouting is also reported from south-west Forfar, while in Orkney rot is in evidence; in Lewis and Harris disease is widespread and serious.

Despite the trying weather during January and February, ewes on arable farms are reported to be in fair condition. On hill farms, however, flocks suffered more severely owing to the inclement weather. Lambing was in progress at the end of February on arable farms in Forfar, north-east Fife and the Lothians, but elsewhere regular lambing had not then commenced. The turnip crop has kept fairly well on the whole and the supply is adequate except in Kincardine, Roxburgh, Uist and some parts of the Lothians and Dumfries. Keep of all kinds is plentiful in Berwick, Shetland, Orkney, Caithness, Sutherland, Central Argyll, Kintyre, Renfrew, North Ayr and the western islands, but elsewhere the supply of hay and straw is short, or barely sufficient for requirements. Feeding cattle have made little progress owing to

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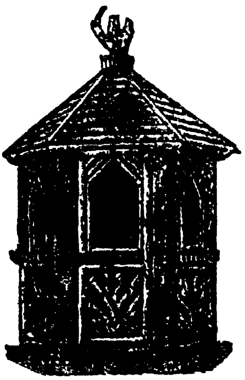

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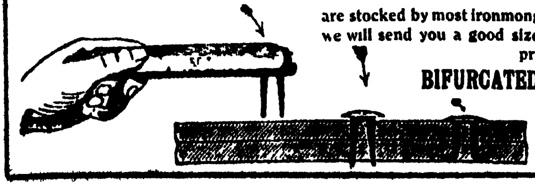

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the recent wet conditions, but in most districts they are said to be healthy, apart from the outbreak of Foot-and-Mouth Disease.

The supply of regular workers is generally ample for present requirements and in south-west and east Aberdeen, central, south-west and south-east Perth and central Argyll some men are reported to be unemployed. In Renfrew, milkers and dairy workers are difficult to secure, while in Berwick, women workers are short of requirements.

RECENT PERIODICAL LITERATURE.

The majority of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins, and to the original publications quoted therein, may be obtained on application to the Secretary, Board of Agriculture for Scotland, 29 *St Andrew Square, Edinburgh.*

The Spring Awakening of Arable Land. *A. Lumière. Comptes rendus de l'Acad. des Sciences.*—In the temperate zones, the arable land awakens at the end of the winter to greater activity, which is chiefly shown by the germination of the seeds it contains, and by the recrudescence of nitrification in the soil.

Putting aside the suggestion advanced by Müntz and Gaudechon, that this re-awakening of the land in spring is due to the atavism of the micro-organisms, the author has sought to discover another cause of this seasonal rhythm, and has put forward the hypothesis that an important part in the phenomenon in question is played by the toxic products secreted by the roots of plants, or resulting from the transformation of plant remains after the fall of the leaves and the death of annual species, for a certain time is needed before these toxic products can be destroyed by fermentation or oxidation, or can be diluted or removed by rain.

This idea has been confirmed by the following experiment:—A sample of garden soil that had been under cultivation during the preceding summer, was taken by the author in November. This homogeneous sample was divided into two similar portions, one of which was repeatedly washed with distilled water in order to remove most of the soluble matter present in it, while the other was simply watered with similar distilled water. At the laboratory temperature, the small plants that usually appear in spring began to grow with great rapidity after a few days upon the surface of the washed soil sample, whereas the unwashed sample, although liberally watered, remained sterile. The washing had removed all the substances that prevented the germination of the seeds.

By extracting systematically the toxic matter in 10 kg. of the same soil, and then evaporating the washing water at a low temperature until reduced to 1 litre, the author obtained a reddish solution containing a total of 28 gm., of total solids. When this solution was used for watering, it absolutely prevented all germination, no matter what soil was selected or what the season might be.

Seeds soaked in this extract for some days did not lose their power of germinating, provided the extracts products, which did not seem to be actual toxins, but merely inhibitory agents were removed by thorough rinsing.

The bodies preventing the germination of the seeds are not destroyed or even altered by heating them at 130° C. for half an hour in an autoclave, and would thus seem to be composed neither of toxins nor diastases.

The author continued his experiments with a view to devising some simple and practical methods of either saturating or destroying these substances, as by this means it would be possible to improve, within considerable limits, the economic conditions of crops.

He first soaked for twelve hours in 2 litres of water lots containing 500 gm. each of the débris of dead plants; he then used the leaves of chestnuts, plane-trees and of various fruit trees that had been collected as soon as they had fallen. He found that these solutions possessed very definite reducing properties, and apparently contained phenolic bodies. They completely prevented any seeds from germinating.

Under natural conditions, the fallen leaves and plant *débris* undergo progressive disintegration, and finally turn into humus.

It is well known that germination is characterised by very intense oxidation processes ; in the absence of oxygen, it cannot take place. At the time when annual plants die, and the trees shed their leaves, the rain dissolves the soluble, reducing bodies contained in this organic matter, and impregnates the soil with substances that absorb the oxygen, thus depriving the seeds of this element, which is absolutely necessary for their germination.

The same processes may continue for a short time at the beginning of the decomposition of the plant remains.

After the leaves fall, the soil will therefore remain sterile until such a time as the atmospheric oxygen that has penetrated into the soil, either directly or dissolved in the rain water, shall have completely oxidised the reducing matters it contained.

This fact explains the great importance of ploughing operation, which bring to the surface the layers of soil that are full of sterilising agents, and thus destroy the paralysing effect of the latter.

It further accounts for the awakening of the soil in the first days of spring as soon as the higher temperature can hasten the completion of these reactions, thus bringing to its termination the cycle that should be completed at this season of the year.

The author intends to continue his experiments, not only for the purposes of contributing to the accurate knowledge of plant biology, but also with a view to discovering some means of restoring to the soil, early in the spring, the fertility which it loses temporarily during the winter through the agency of the reducing substances of which he has demonstrated the origin.

Variations in the Composition of Wheat. *Comptes rendus de l'Acad. d'Agric. de France.*—A note by MM. Rousseau and Sirot communicated to the Academy by M. Lindet.

The authors have previously remarked that the quantity of soluble nitrogenous substances contained in good flour is very nearly constant, and that by this means the bread-making qualities of flour can be judged. Since then the authors have analysed wheat grain in all stages of development, including grain soaked by rain, to the time of germination. The proportion of the soluble to the nitrogenous matter, which was 49 per cent. at the end of June, fell to 10-14 per cent. by the end of July, and increased to 36 per cent. under the influence of germination.

The authors also studied the parallel progress of the soluble and total phosphates. The proportion of soluble to total phosphates was 76 per cent. at the beginning of grain formation, fell to 35 per cent., and then reached 42 per cent.

The acidity follows the same curve ; it started at 0·300, fell to 0·030 and rose again to 0·050. It can therefore be said, in agreement with previous research, that an abnormal composition of the wheat corresponds to insufficient maturation or a tendency to germination.

Some Superior Varieties of Swedish Barley obtained by Line Selection or by Hybridisation. *H. Nilsson Ehle, Stockholm.*—NEW VARIETY OF BARLEY WELL-ADAPTED TO CONDITIONS IN SWEDEN.—This refers to variety "0412" obtained by selection from Chevalier, and surpassing it in yield, owing to its stronger straw and earlier maturity.

Compared with "Princess," one of the most favoured varieties at the present time, 0412 produces equally well, matures earlier and possesses stronger stems. There is a promise, therefore, of a distinctly satisfactory combination of characters ; it is only slightly inferior to "Gullkorn" as regards date of maturity. This new type is also remarkably resistant to *Heterodera schachtii*, to which Gullkorn and Princess are, on the contrary, generally liable.

Practical cultivation trials carried out on a large scale from 1910-1919 in the Malmöhus district certainly confirm the above statements, and support the claim that 0412, like Princess and Gullkorn, is one of the best varieties tested so far in Southern Sweden; these three types can reciprocally replace one another in accordance with the special local conditions, geological and climatic.

DEGREE OF RESISTANCE OF THE DIFFERENT VARIETIES OF BARLEY TO *Helminthosporium gramineum*.—Amongst the more common varieties distinct differences have been observed and controlled experimentally with regard to their resistence to *Helminthosporium*. The Tystofte Korsbyg variety (Danish) occupies the first place as regards resistance. In a series of tests carried out by D. Peterson at Köpenhamm, Tystofte Printice showed 8 per cent. of infected plants, Julibyg 8 per cent., Fredriksens Gradbyg 23 per cent., Karlsbyg, evidently the most liable to attack, 48 per cent. It might be possible, however, by the aid of opportune crosses, proceeding from Tystofte Korsbyg, to obtain resistant types, with other desirable characters at the same time.

In any case, the character of resistance is subject, like all other characters, to the phenomena of splitting which make the work of fixing the types a tedious process. By crossing types of an average resistance, transgression phenomena are often liable to occur with the appearance of plants that are more resistant than the most resistant parent and others more susceptible than the most susceptible parent.

Thus, in the F_2 of the Chevalier × Gullkorn cross studied in 1919 at Akarp (Sweden), a considerable number of infected plants were observed, whilst the parents were practically all immune; this may perhaps be due to local conditions, but in any case this phenomenon should be kept in sight, as the possibility of a negative transgression cannot be excluded.

The investigations made by Kiessling at Weihenstephan (Bavaria) confirm the results obtained by Danish and Swedish investigators. Although the actual percentage of diseased plants may vary in limited areas from one year to another, and from one locality to another, according to local conditions, the heredity of the character of resistance manifests itself each time with absolute certainty. The investigations made by Kiessling also demonstrate the existence of resistant and susceptible varieties in every group; *nutans*, *erectum*, etc. The general opinion that attributes the most marked degree of susceptibility to the *erectum* type is completely erroneous.

Resistance can evidently be associated with morphological characters which serve to differentiate between the various groups.

Modifications in the Usual Form of Cultivation of Potatoes. *Schribaux*, *Comptes rendus de l'Acad. d'Agric. de France.*—Report of information received from Dr Maisonneuve giving an account of comparative tests carried out at Angers with the potato, using (1) whole sets; (2) cut sets weighing 8 to 10 gms. with one eye.

The cut sets were exposed to the sun for 102 days, in order to allow the wounds to callus, and were then planted in rows 12-14 cm. between the sets.

Four experiments out of five gave results indicating that small and medium cut sets give higher yields than whole sets. In the first tests the medium cut sets produced 40 per cent. more than the whole sets, and gave larger tubers. In the second test the small cut sets gave 80 per cent. more than the whole sets.

M. Schribaux remarks that he has already had the opportunity to notify similar results. Evidently it has to do with a fertile area. The question still lies open as to the behaviour of these different methods of cutting relative to various soils, weather conditions, varieties, etc.

Wart Disease of Potato affecting Tomato Plants in Pennsylvania. *Weekly News Letter*, *Washington.*—Investigations made by the United States Department of Agriculture on the control of the potato wart disease (*Synchytrium endobioticum*) disclosed the fact that this disease also attacks tomatoes. Out of 28 varieties of tomatoes planted in the wart-infested gardens of eastern Pennsylvania, 26 were found to be susceptible to the disease.

The disease attacks only the stems and roots of the plant, causing the formation of small warts; it probably does not reduce the yield of fruit.

The importance of the discovery of the susceptibility of tomatoes to potato wart lies in the fact that affected tomato plants will serve to carry the disease over from year to year in the absence of potatoes, and to introduced it into new localities through the transplanting of tomato seedlings grown in infected soil. It is not yet definitely known whether all varieties of tomato are susceptible to wart disease, but it is feared that such may be the case. Other plants belonging to the Solanaceae are suspected of being susceptible to wart, and some have already been tested, but with inconclusive results; the tests will for this reason be repeated.

The Lime Factor in Permanent Soil Improvement. *J. G. Lipman and A. W. Blair, Soil Science, Baltimore.*—A report of work covering a period of ten years including the study of the sources of nitrogen, the proper amount to apply, the influence of nitrogen on the yield and composition of the crop, denitrification and other nitrogen losses. On account of the important bearing which the reaction of the soil has on the nitrogen problem, the plan was made to include the use of lime in the carbonate form.

I.—The soil on which the experiments were conducted contained originally 0·11 per cent. nitrogen and 1·22 per cent. of total carbon, and no lime had been applied within recent years. The lime treatment consisted of finely ground limestone or oyster shells at the rate of 1 ton per acre just before planting the maize in 1908, and 2 tons per acre again preceeding the maize in 1913, the liming thus taking place at intervals of five years. A careful record was kept of the amount of nitrogen applied in the form of manure and fertiliser, and likewise of the amount removed by the crops. The five-year rotation practised was maize, oats, wheat and two years of timothy. No legume crops were introduced. Twenty plots with different nitrogen treatment were thus limed, and twenty similar plots with parallel nitrogen treatment were left without lime. The total yield of dry matter and of nitrogen for the ten-year period were essentially the same for the two sections.

Analysis of the soil made soon after the work was started and again at the end of each five-year period, showed that there was a loss of nitrogen from both the limed and unlimed sections. However, the loss from the limed section was distinctly more marked.

Results appear to indicate that the practise of using lime on light to medium heavy soils, when leguminous crops are not grown in the rotation, may be questionable. Under such conditions it is quite possible, according to the authors, that a slightly acid reaction may be desirable to prevent the too rapid oxidation of organic matter. On acid peat soils, and poorly drained heavy clay soils, where there is a large amount of oxidisable organic matter, or where oxidation proceeds very slowly, lime may however be used in connection with the growing of non-legume crops to excellent advantage.

II.—An attempt is made to show the influence of lime in four different rotation systems, all of which include some legume crops, either as one of the main crops, or as a green manure between the main crops. Two five year periods for each rotation were completed. Acid phosphate 300-400 lb., and muriate of potash 100 lb. per acre were applied and light applications of commercial nitrogenous fertilisers were also made. No farmyard manure was used.

During the ten years the limed plots, with only slight exceptions yielded distinctly larger crops and more nitrogen than the unlimed plots. In most cases, the yields were larger with the 2000 and 4000 lb. applications, than with the 1000 lb. application. There appeared to be a slight difference in favour of the magnesium lime stone, in preference to the calcium lime-stone.

The use of lime thus resulted in a gain in both quantity and quality of the crops produced. Analysis of the soil showed that in a number of cases, there was a higher nitrogen content for limed than for unlimed plots; in other cases, the two were about on a level as to nitrogen content and in a few cases, there was apparently a development of nitrogen in the limed plots.

Compared with the results of the former experiments the authors suggest that in using lime, emphasis should be laid on its power to make conditions favourable for the organisms associated with leguminous crops rather than on its power simply to neutralise soil acids. Its value is more indirect than direct.

The Ehrenberg Law on the Relation between Potash and Lime. *A. Mayer, Berlin.*—The law in question is formulated by Paul Ehrenberg as follows:—Every time that the amount of lime available is increased for a plant which has but little potash at its disposal, the absorption of potash decreases, with consequences that may be very harmful. But if the supply of potash is increased proportionately, the plant will be safeguarded against excess of lime and will attain perfect development.

According to the author, Ehrenberg's law can be amply substantiated, and it clears up facts which until now have remained unexplained. All the harmful effects of lime are thus connected with a lack of absorption of potash; the apparent calciphobia of lupins and numerous other herbaceous and arborescent plants can be clearly explained by this law.

Nevertheless, the author considers that it is not a case of a law of a special kind, but of the consequence of the general law of absorption, which is based, not on mysterious selective powers, but on determined physical laws regarding osmosis, as well as on determined physiological laws regarding the fixation of substances which are absorbed in a form which is no longer diffusible. In fact, if several salts are awaiting entrance into the roots, each stands less chance of being absorbed in considerable quantities. The excess of another base in addition to lime, will thus influence the reduction of the absorbtion of potash.

It is necessary to consider, besides, the two independent properties which most crops possess, viz., those of a greater or less need of lime and potash and of a greater or less aptitude for appropriating them at the expense of substances of varying assimilability. As regards this, the author suggests that special tables should be drawn up to show these two properties in different plants, which would be of practical use for fertilisers and crop rotations.

The author states that the direction followed by agricultural chemists who wish to confine metabolism to the narrow limits of physical and mathematical knowledge is entirely erroneous.

The Theory of Probabilities applied to Field Experiments. I. *T. Roemer,* II. *W. Schneidewind, D. Meyer and F. Munter, Berlin.*—I. TECHNIQUE OF FIELD EXPERIMENTS.—The author attributes great importance to the use of the calculation of the probable error in improving the technique of field experiments. The present technique is not sufficient for the examination of the capacities of numerous varieties, where it is necessary to determine slight differences; in fact, the average error in the field, in the case of fertilisers and varieties, in spite of every care, is from 5 to 7 per cent., whereas it should not exceed 3 per cent. Countless mistakes are made even in sowing, and these errors vary according to the character of the seed and the manner of sowing it.

In the case of plots, the experiments of Montgomery, Mercer, Hall and Larsen did not give concordant results.

As regards the area of the plots, it was found that the accuracy increased with their size, whereas Toulaikov, Wood and Stratton were convinced that the error is independent of the size of the plot.

After making a comparison between three different systems of arranging the plots, each carried out with twelve square plots in one, two or three regular lines, it was found that the most accurate results were obtained when the plots were arranged in two lines only. Repetition contributed more to exactness than did the size of the plots.

II. EXPERIMENTS ON THE SIZE OF THE PLOTS.—The use of the theory of probabilities in testing the accuracy of field experiments is of quite recent date. The object of the authors is to establish the crops (expressed in terms of a hectare) born by plots of different sizes and arrangement, and to determine the importance of the application of the theory of probabilities in testing the results of the experiments carried out in the plots when these data have been converted, and expressed in terms of areas that are of appreciable practical size.

The experiments were carried out on a piece of very uniform, flat land belonging to the Station of Lauchstädt; the area of the plots, whether separate or contiguous, was 200, 100, 90 sqr. m. each, the first being rectangular, and the second and third square. In 1913, sugar-beets were grown in them, in 1914 and 1915, winter wheat was cultivated, in 1916 and 1917, they were under barley. The results were as follows:—

(1) The plots separated from one another, in accordance with Pfeiffer's advice, by strips of uncultivated ground, 80 cm. wide, did not yield satisfactory results, either because the yield per hectare was too high (the smaller the plot the higher was this yield), or because the fertiliser, partly owing to the heavy crop, had much less effect.

(2) The yield of the contiguous plots of 9, 100 and 200 sq. m. when converted and expressed in terms of a hectare, gave more uniform data, especially when liberally manured, so as to compensate for differences in the soil conditions. The increases in the crops obtained by manuring plots of different size are not such as to guarantee sufficient agreement in the results.

(3) The application of a fertiliser to a plot has no particular effect on the contiguous plot, if it is spread in such a manner that its external limit falls within the last line of the plants sown on the manured plot.

(4) The differences between the largest and smallest crops for each group of plots, when expressed in terms of a hectare, vary in inverse proportion to the size of the plots.

Electroculture. *R. D. MacCrecy, Scientific American*; II. *Electrical Times, London.*—When direct current is driven through an electrolyte the negative ions move to the positive electrode and the positively charged ions move to the negative electrode. When alternating current is used this is not the case; the ions move rapidly first in one direction towards one electrode, then in the opposite direction towards the other. They are as it were in a state of intense vibration of an oscillating nature, caused by and in unison with the waves of the alternating current. What then happens if we discharge high frequency electricity through an acre of soil to metallically coated seed, from electrodes (parallel to each other), embedded in the earth?

The earth is in this case the electrolyte, in which, by the action of water, there have been gaseous ions set free. When the electricity is applied, these ions set up an active bombardment on the seeds and tiny roots of the plantlet and since the seeds and roots are porous it must be evident from a mechanical standpoint that some absorption, by the plant, of the gaseous ions takes place. After being absorbed by the plant roots these ions are still subject to the influence of the high frequency electricity which, during application, will set up vibrations within the cells of the plant. Such an action will mechanically enlarge the cells in the tissues of the plant and allow it to grow more freely.

The discharge of high frequency electricity through soil is also equivalent to aeration since it causes air to be drawn into the soil with it. This is in a great measure the principal benefit derived from cultivation and is, therefore, an important factor in agriculture because of its stimulation of bacterial action. Moreover, the discharge of high frequency electricity through the air combines with the moisture in the soil to produce nitric acid, which contains nitrogen in a form readily available as plant food.

On the other hand the electronic collisions of the ions with alkalies in the earth produce nitrites. The earth in a sense becomes a storage of nitrogen that must be changed by the soil bacteria before it becomes available as plant food. This makes work for the soil-building bacteria. In 1909, Prof. G. E. Stone of the Massachusetts State Agricultural College, proved in a series of tests that by discharging each day a few sparks of static electricity through soil containing bacteria these organisms in seventeen days increased 600 per cent. There is another influence of electricity on the bacteria which might be termed bacterial stimulation. Bacteria are sluggish micro-organisms and the galvanic action of the current on their bodies increases their activity.

With the above proven facts in mind, it is not at all surprising that increases in production have been reported where electricity has been properly applied to promote the growth of vegetation.

II. A short note is given of the results obtained from electroculture with electric discharge at Chester. The outstanding fact is that the four varieties of potato that were tried gave decreases. On the other hand, peas, broad beans, French beans and beetroot gave increased yields of 27, 26, 28 and 88 per cent. respectively, compared with the control. It is suggested that the bad results were due to the abnormal rainfall when the growth was nearing maturity.

The Influence of Cold in Stimulating the Growth of Plants. *F. V. Coville, Easton, Pa.*—The author gives contradictory evidence to the general belief that native trees and shrubs become dormant because of the cold, and that warm weather is in itself the sufficient cause of the beginning of new growth in spring.

Dormant trees and shrubs which had had two or three months of chilling, either outside or in artificial cold storage, started into growth in the normal manner in the spring, but if kept warm all the winter they did not start into growth at the usual time, but continued their dormant condition for weeks and months, and sometimes for a whole year. When finally growth commenced it was of an abnormal character. One of these dormant plants was found to be readily started into healthy growth even after a year, by subjecting it to a period of chilling. The best temperature for chilling was 32° to 40° F., applied either in light or darkness. By subjecting one part of a dormant bush to a chilling temperature and keeping another part of it warm, the chilled portion was brought into full leaf and flower while the other part remained completely dormant.

During the process of chilling, the starch stored in the cellars is transformed into sugar and this is necessary before the plant can utilise its store of starch in making spring growth. If warmth alone would start growth, the stored food required by the plant for its normal vigorous growth the following spring would be wasted in a burst of new autumn growth, which would be killed by the first heavy frost and cause ensuing weakness and probable death.

Further investigations are urged, especially in the determination of the proper temperatures for the storage of different kinds of seeds, bulbs, cuttings and grafting wood; for the treatment of plants which are to be forced from dormancy to growth at unusual seasons, and for the storage of nursery stock so that the nurseryman may have plants in proper condition for shipment at any date.

Action of Chloropicrin on the Germination Power of Seed. *E. Miège, Comptes rendus de l'Acad. des Sciences.*—Various workers have shown that chloropicrin is a powerful insecticide which is effective for the destruction of certain parasites. The action of chloropicrin on the germination power and the cultural value of seeds, however, remained to be determined.

In a previous experiment on a large scale several quintals of different infested seeds (pea, bean, wheat, etc.) were treated, either by watering the closed sacks, in the way indicated by M. G. Bertrand, or by placing the chloropicrin in vessels placed close to them. With a dose of 20 c.c. per cubic metre of space, or per sack of about 80 kg. the pea-weevil (*Bruchus pisi*), bean-weevil (*Br. obtectus*) and the grain-weevil (*Calandra granaria*) were, in both cases, radically destroyed within twenty-four hours without any apparent harm to the germination power. The wheat alucide (*Sitotroga cerealella*) was also completely destroyed under similar conditions.

In a second series of experiments in the laboratory, samples of seeds of various cultivated plants were placed in dishes under a bell-jar and treated for varying periods with chloropicrin in doses varying from 15 to 50 cc. per cub. metre. Afterwards the seeds were removed and put to germinate under filter paper in the open air without artifical heat, and compared with untreated controls.

The results show that the destruction of insects parasitic on seeds (wheat and bean weevils, alucides, etc.) is assured by the use of chloropicrin, acting for twenty-four hours in doses of 15 to 20 cc. per cubic metre. Longer periods of contact and larger doses do not appear to be any more effective.

The action of the chloropicrin on the seeds varies with their nature, the dose given, and the duration of treatment. Certain seeds of legumes, flax, etc., are not affected by it, but in others, such as hemp, beets, etc., and, in particular, cereals, it affects the germination energy and power. This unfavourable influence usually increases with the quantity used and the time of contact.

Under the conditions required for disinfection the germination power of wheat is decreased by 30 per cent., a percentage which increases with stronger doses. On the other hand, leguminous seeds are absolutely immune.

A New Process of Seed Preparation in Canada, *A. Eastham, Agric. Gaz. of Canada.*—A new method of cleaning and grading seeds and grain has been invented and patented by E. E. Eddy, formerly Chief Seed Inspector of the Department of Agriculture. The separation is made entirely on the basis of comparative specific gravity. This is effected by subjecting the stock to centrifugal action in the presence of a liquid which is of the specific gravity required for the separations desired.

A suitable material for making a liquid of the desired density is sodium nitrate, but other substances may be used. With seeds weighing about 60 lb. per measured bushel, such as alfalfa and clovers, a solution of about 1·2 specfic gravity is required. By regulating the density of the liquid, the proportion of seeds which pass into the heavy and light separations is under complete control.

Tests of several samples of red clover showed a perfect separation of several kinds of the most common weed seeds, classed as noxious under the Seed Control Act. Almost equally valuable were the results in reducing the less harmful species.

Equally good results were obtained with alsike, alfalfa and timothy seed. Tests so far have been made mostly with small seeds. It is expected, however, that valuable results will be secured also with grains by removing barley and oats from wheat, oats from barley, etc., in addition to the separation of weed seeds.

The process is now being developed with the idea of putting it on a commercial basis, and should this be accomplished, there should be a great improvement in the purity and general quality of the seed available.

Clover Sickness: Eel-Worm and its Control.—The presence of Eel-Worm (*Tylenchus dipsaci* or *devastatrix*) in a crop is shown by the wilting and withering of young plants. In the Rhine province of Germany this is particularly noticeable in the two- or three-leaved stage of winter-sown rye, as well as in clover crops. There, as in this country, it has been found desirable to bury the eel-worms to some depth in the soil, but while here deep ploughing has been the means adopted, E. Schaffinit recommends that root-crops should be repeatedly grown, so that the nematodes may be driven down from the surface to layers where moisture is present. The moisture reawakens dormant activity in the worms, which then die from lack of food. Quick development of plants during the susceptible stage is desirable, and for this purpose manuring with saltpetre is recommended. Farmyard manure must on no account be used for an infected crop. It seems likely, however, that greater promise of successful control is offered by the new methods of soil fumigation, and Schaffinit states that excellent results followed his application of sodium cyanide to the soil, where it caused effective disruption through the production of hydrocyanic acid.

The Destruction of Millipedes. *J. L. Horsfall and J. R. Eyer, Jour. Econ. Ent., Geneva, N.Y.*, 1921.—Good results in America have followed soil disinfection as applied for the destruction of millipedes, which do much damage to seedlings of tomatoes, carrots and other plants, especially under frames. The recommendation is made that sodium cyanide, at the rate of 150 lb. an acre, be sprinkled in furrows on the plant bed and covered over. Such a distribution on a plot of 48 sq. ft. resulted in the production of 256 plants more than grew on an untreated plot. Other remedies were less successful: nicotine sulphate sprayed on a freshly-seed bed, in a strength of 1 part in 200 of water resulted in a production of 224 additional plants, and the same poison sprinkled as a dust of 2 per cent. strength produced 114 additional plants. A poisoned bran mash, the active constituent of which was sodium arsenite, was found to be an effective protection in spring, but in autumn it was ineffective, owing, it was thought, to the different seasonal habits of the millipedes.

The Bean Aphid. *Feldt, Rev. Appl. Entomology.*—"As aphids (*Aphis rumicis*) first appear at the edges of a bean field, and then spread towards the side sheltered by the wind, it is necessary to choose exposed situations and to aim at early blossoming. The seed should be submerged in mercuric chloride for two hours, and then in water for twenty-four hours. Another measure consists in making the drills run north and south; drills running east and west yield taller plants, but they are shaded and more protected from wind, and the crop is smaller. Carrots, hemp, parsley and coriander repel aphids. Early potatoes should surround the bean field."

The Arab Horse and its Genetic Value. *H. K. Bush Brown, Jour. of Heredity, Wash.*—The following are the anatomical differences which distinguish Arab horses from the other races; head smaller and broader; nose finer; eye large and more prominent and alert; head articulated on to the neck at a more obtuse angle; chest broad; bones of the legs clean and very dense; etc. These differences are sufficient to mark the Arab as a separate family and the five lumbar vertebrae instead of the six common to all other horses seem to place him in a separate species. Occasionally the shortness in the back appears not in the lumbar vertebrae, but in the dorsal, seventeen instead of eighteen; the total vertebrae number twenty-three instead of twenty-four common to all other types.

Skeletons of various types have been examined at the Museum of Natural History, New York, where there is also a a skeleton of a wild horse of Asia, the Prejevalsky, and also one of a Kinag, each with nineteen dorsal and five lumbar vertebrae. These are considered merely individual variations, the first lumbar having developed ribs instead of the usual lateral flanges. Similar individual variation has been found in a work horse, and a Shetland pony, each with nineteen dorsals and six lumbars. Also a Grevy Zebra which had eighteen dorsals and seven lumbars.

The short back renders the Arab horse more capable of carrying weight, and the larger abdominal capacity enables him to carry relatively more food for a long journey and he can endure privation better.

The ass, with a good weight carrying capacity has also the short back of five lumbar vertebrae.

The author states that the short back (*i.e.* twenty-three vertebrae instead of twenty-four) is dominant only in the first generation of outbreeding (Arab horse × trotting stallion). In all other cases this short back is a recessive character. However, occasionally cases of atavism or reversion have been noticed, and several examples are quoted. Out breeding of the scrupulously pure Arab is therefore necessary. The Arab horse stamps his good qualities in his descendants for many generations and consequently is of distinct genetic value.

The Efficiency of Purdue Calf Meal as a Milk Substitute in Calf Feeding. *G. Spitzer and R. H. Carr, Purdue Union, Agric. Expt. Stn.*—Purdue calf meal consists of maize meal, linseed meal and liquid beef blood (8 : 1 : 12) plus steamed ground bone to the extent of 1 per cent. This is dried for from four to six hours at a temperature not over 140° F. and then ground.

An hour or so before feeding it is mixed with four times its weight of warm water, forming a jelly. This is again diluted at feeding time and is fed at blood heat. Liquid blood meal, thus prepared, was more readily digested than commercial dried blood.

A group of thirty-six grade Holstein calves varying in age from ten to twenty days, and in weight from 85 to 126 lb. were fed for 140 days. A lot of twelve, receiving whole milk throughout, showed an average gain of 1·91 lb. per head. A similar lot fed on skim milk, after the first ten days showed an average daily gain of 1·73 lb. and a third lot fed on Purdue calf meal gained 1·18 lb.

Ground maize and oats (1 : 1) was fed as a dry mash to each lot, and for part of the time the calves had access to bluegrass pasture (*Poa pratensis*) or clover hay.

The calf meal lot were thrifty and remained in good condition, and during six months of pasture following the feeding period, they gained about the same amount as the other lots.

The Effect of Drugs on Milk and Fat Production. *F. A. Hays and M. G. Thomas, Jour. of Agric. Research.*—The opinion that milk production and butter-fat yield can be influenced by the use of drugs is widespread among dairymen. The objects of the author's experiments were:—(1) To determine the effect of various drugs on the butter-fat test of milking cows; (2) to study the effect on the total fat yield of producing cows; (3) to determine whether drugs have an effect on the health or on total milk production. The four cows of mature age selected for experimental purposes included one grade Holstein, one pure-bred Holstein, and two pure-bred Guernseys. The interval of experimentation with each drug was five days. The control and experimental periods alternated, and the order in which the drugs were given was so arranged that each cow received one of the eight drugs for a five day period. The cows were milked twice daily, the weight of milk recorded, and composite samples from each cow were tested for butter-fat daily.

A study of individual records and average records does not indicate that drugs have a very pronounced effect on the production of the dairy cow. Air-slaked lime, however, fed in 2 oz. doses daily, may possibly increase milk production and total fat yield, but no other drug or mixture tested proved to be of any marked value. Results do not indicate that the difference in character of milk of Holstein and Guernsey cows, has any relation to their manner of reaction to drugs.

Payment for Milk according to its Fat Content. *C. Porcher and E. Vitoux, Comptes rendus de l'Acad. d'Agric. de France.*—In certain countries milk is bought at a price in proportion to the fat content. The authors maintain that purchase on this basis is insufficient and ought to be supplemented by a factor relating to the quantity of dry fat extract. For this two very simple tests are sufficient, the first being the total fat content determined by the Gerber method and the second the density of the milk. In addition the "freshness" of the milk (microbial qualities and cleanliness) must be taken into account. The determination of the acidity of the milk, a usual dairy process, gives an approximate measure of the microbe content of the milk.

The Influence of Dry *versus* Fresh Green Plant Tissue on Metabolism. *E. B. Forbes, Science, N. Y.*—A report of experiments with cows carried out in the department of Dairy Husbandry at the Ohio Experimental Station. Since 1911, a group of Holstein-Friesian cows were maintained on dry feeds and silage alone. No green feed was allowed. Several of the animals now in the group were born in it, and had reached maturity entirely without green feed.

The said cows grew to normal weight, and produced and reared calves without marked or certain irregularity or abnormality. The milk production was fair only, it being obvious that with normal treatment these cows would have given more milk. They were easily forced off feed, and were noticeably in a less thrifty condition, as indicated by flesh and coats, than the balance of the herd, which went to pasture.

During the summer the author conducted palatability tests on these cows, with various mineral supplements, consisting of various calcium phosphate and carbonate preparations, fed alone or mixed with common salt. The cows showed a keen desire for such feeds, having eaten in several short periods from approximately ¾ lb. to more than 1¼ lb. of mineral supplement per head per day. The avidity with which steamed bone was eaten, considered in connection with the discovery that negative calcium balances normally prevail during lactation in cows in dry feed, and the conclusion of Hart, Steenbock and Hoppert, that fresh grass favourably affects calcium retention, suggests that these dry-fed cows are in a state of mineral depletion, especially while giving milk. This suggestion appears, therefore, to be a matter of practical importance in connection with milk production, but rations of dry feeds and silage, though probably deficient in some constituent, are not entirely lacking in any essential.

Inoculating Cattle against Tuberculosis. *A. Calmette and C. Guérin, Annales de l'Institut Pasteur, Paris.*—The experiments carried out by the authors from 1912-1915 revealed the following facts :—

(1) By means of successive series of cultures of the bacillus of bovine tuberculosis, a race of non-tuberculigenous bacilli can be obtained that are perfectly tolerated by cattle and other animals susceptible to the virus of tuberculosis.

(2) This non-virulent race behaves as a true vaccine, in that, when injected in the right amount into the veins of cattle, it makes these animals immune, not only against experimental test inoculation, but also against infection due to living in close quarters in a contaminated shed.

(3) This immunity, which presumably depends upon the presence of the non-virulent bacilli in the organism, only lasts eighteen months after vaccination, a process which in itself is quite harmless.

The Dipping of Sheep in So-Called Carbolic Dips. *A. Stead, Jour. of Dept. of Agric., S. Africa.*—The object of this paper is to warn both sheep farmers and dip proprietors that, while these so-called dips are safe with some waters, they are unsafe with others. The most dangerous water appears to be of the moderately hard type, because the oily globules separated under these conditions are very small and easily overlooked.

Investigations were carried out with three different coal tar dips. In the first case (mixture and water in the proportion 1 : 50), of the first lot of twelve dipped, six died ; of the second lot of twenty-one dipped, five died ; of the third lot of thirty-five dipped, none died. Examination of the dip showed that it did not contain arsenic, that true phenol was practically absent, but that it contained higher phenols, pyridine, hydrocarbons, soda and water. It was not found possible to obtain a true emulsion by mixing with either fountain or distilled water ; but distilled water mixtures contained very much less separated oils than the fountain water mixtures. The most perfect emulson was obtained by boiling the distilled water before mixing, the explanation being that boiling expelled dissolved carbon dioxide from the water. A slightly improved emulsion was obtained with fountain water by placing it in a vacuum chamber (to remove carbon-dioxide) before mixing. An equally good result was obtained as that made with unboiled distilled water, by softening the water with soap prior to mixing, and also by partially softening the water prior to use by boiling.

The author's conclusion is that the first sheep dipped took with them out of the tank, not a chill, as was suggested, but separated oils ; that they were, in effect, dipped in too strong solution. The fact that all the sheep were not affected in a similar way may be attributed to the fact that the separation of oils was not found to be an instantaneous process and that some sheep were more resistant than others.

In the second and third cases, the results of the dipping were of a similar nature to the first, and bear out this point.

Recommendations.—(1) To free the dip wash of its separated oils by drawing absorbent material through it ; (2) to soften the water before using, or by adding more soap to concentrated dip ; (3) to use small tanks ; (4) to wash the animals well with a solution of Epsom salts and water ; a hypodermic injection of a watery solution of Glauber salts is also advised.

The most reliable test probably, for the separation of dip oils in doubtful cases, is to prepare some of the dip wash and pour it through a piece of blotting or filter paper folded to fit a funnel. Some at least of the separated oils should be retained by the paper. The risk that sometimes attends, the dipping of sheep in these fluids has also been noted in America.

A Mechanical Method of Combating Sheep Maggot Fly. *D. H. Bennet, Texas Agr. Exp., St. Circ.*—In the United States, as in this country, a considerable amount of damage is done to sheep flocks by the presence of the Sheep Bot in the nasal passages of sheep. There, as here, the methods ordinarily adopted for prevention of infection by hand-dressing the sheep's nose have been found to be too costly, except in the case of highly-bred stock ; and as a result the following mechanical method has been devised. A salt trough, instead of being left open, is covered with a board, the sheep having access to the salt only through holes bored in the wooden cover. The holes are smeared, at intervals of three days, with a mixture composed of 1 pint of white tar and 2 oz. oil of eucalyptus, and the salt is kept at such a level in the trough that the sheep in touching it is compelled to touch the edge of the holes with its nose. The vulnerable part of the sheep thus acquires a protective dressing, and it has been found that a large proportion of larvæ of the sheep-maggot fly deposited on such dressings die.

Inoculation with Serum as a Prophylactic against Swine Fever. *Izcara D. Gargia, Madrid.*—Experiments carried out with a view to determining whether inoculation with serum renders animals immune to swine fever.

An attempt was made to obtain a more active serum by substituting intraperitoneal injection for subcutaneous injection, and by replacing Iberian pigs, which are excessively susceptible, by Celtic swine, which are very resistant to the action of the virus.

First, sixty-nine pigs were injected with 20 cc. of serum ; ten days later the animals were injected with ¼ cc. of virus, a similar injection being made after ten days. Eight days subsequent to this last injection, the sixty-nine pigs were removed to infected places and divided into five lots, the first containing ten animals, the second twenty, the third six, the fourth eight and the fifth twenty-five. Lots two, three and five were inoculated with the serum in July 1919, when three months old, and until they reached the age of one year, showed no abnormal symptoms. Lot four was inoculated when the animals were eight months old, and till they attained seventeen months they manifested no sign of disease. All the pigs had received an injection of 20 cc. of serum, 0·25 cc. of virus being injected the first time and another 0·25 cc. the second time.

Sucking pigs were also inoculated with serum to see how far they could be rendered immune. Experiments were made upon 1309 of these animals divided into five lots, containing respectively 100, 200, 207, 213 and 319 head. All were treated with 20 cc. of serum and received two injections of virus, the first of 0·25 cc., and the second of 0·5 cc.

At the time of inoculation with serum, lot one was composed of pigs forty days old. Nine of them (9 per cent.) died as a result of the treatment, whereas the deaths among the fifty control animals were 30 per cent. Lots three, four and five, which were made up of pigs fifteen days old, showed no abnormal symptoms after three or even four months.

In conclusion, inoculation with serum is to be recommended for large animals when the fever has made its appearance, for the immunity gained is passive and of short duration.

Inoculation with the serum is the method of immunisation that has given the best results in the experiments carried out by the Stock-Breeding Association.

Report on Egg-Laying Competitions in Victoria, 1915-1919. *A. Hart, Jour. of Dept. of Agric. of Victoria, Melbourne.*—The egg-laying competitions started in Victoria 1904-1905 at the Dookye Agricultural College. Then, six White Leghorns won the test with 1313 eggs for twelve months. In the test concluded at Burnley in 1916, the winning pen produced 1661 eggs, in 1917, 1503 eggs, in 1918, 1405 eggs for eleven months only, and in 1919, 1511 eggs for the same number of months. These results are with light breeds in the wet mash section. Each year the White Leghorns were very much in the majority in the light breed tests. Figures indicate similar comparative results with this breed in the dry mash section.

With the heavy breeds, Black Orpington invariably took the leading place, wet mash section:—1915-16 total eggs = 1507; 1916-17, 1409 (twelve months); 1911-18, 1274; 1918-19, 1366 (eleven months).

In competition seven the most interesting result was that a Black Orpington hen laid 307 eggs in eleven months, the highest result on record.

In competition eight no records were achieved, but the general results were satisfactory. The only other light breeds besides White Leghorn taking part were Ancona and Minorca, the first showing the best results. Among heavy breeds other than Black Orpington, the Rhode Island Reds were the best, and showed superiority to the Silver Wyandottes and Buff Plymouth Rock competitors in 1917-18.

The Fowl Tick. *F. C. Bishopp, Farmer's Bulletin* 1070, *U.S. Dept. Agr.* —Throughout the Southern and South-Western States of the American Union, one of the most serious handicaps to successful poultry raising is the insidious attack of the chicken tick, fowl tick, or "blue bug" (*Argas miniatus*). The presence of the tick, a creature in itself not very visible, may be revealed by the poverty of the fowls, by paleness about the head, weakness in the limbs and marked decline in egg production. Heavy infestation may produce death, and this happens most frequently when fowls are replaced in infested houses which have been vacant for a period, and where a starved army of blood-thirsty ticks await the arrival of healthy prey. Ticks occur not only on the fowls themselves, but eggs, young stages, and even adults are common in cracks and joints and upon roosts. It is therefore as necessary to clear the house of the pest as to relieve the fowls of their parasites.

The United States Department of Agriculture has made a series of tests to discover a medium which would destroy all stages of the fowl tick, and at the same time would have power of penetrating into cracks, and would possess a lasting action. The results show that the most satisfactory remedies are crude petroleum and the wood preservative known as carbolineum, the latter of which, on the ground of greater destructiveness, greater lasting power, and ability to dry into the wood, is regarded as preferable. The carbolineum must be sprayed over the entire inside surface of the poultry-house, special care being taken that the force of the spray plays directly upon all cracks. Fowls should not be allowed to enter the sprayed house the night following treatment, on account of the irritation produced by the fumes on the eyes and mucous membrane. If the house can be sprayed thoroughly. one application of carbolineum is, as a rule, sufficient to destroy the infestation. But in order to facilitate thorough treatment, and since ticks are seldom found on the ground, it is strongly recommended that roosts should be "supported from the floor of the house, and kept entirely free from the walls . . . It is also essential to have the roost fitted together in such a way that it can be examined or taken down with the greatest possible ease." A very simple type of roost embodying these requirements is illustrated.

The cost of spraying is not unreasonable. Carbolineum costs from $1 to $1.50 a gallon, and crude petroleum from 5 to 20 cents. a gallon. A poultry-house 12 feet square would require about 4 gallons of the former or 5 gallons of the latter, so that the total cost of spraying would amount to about $4·50, or about 70 cents, according to the medium selected.

New Agricultural Implements. *P. Larue, La Vie Agricole et Rurale, Paris.*—MACHINE FOR SPREADING LIQUID MANURE IN FURROWS.—The inventor of this machine, Plath, has overcome the difficulty of spreading liquid manure evenly, another difficulty being that it may evaporate both in the liquid above and on the soil. The idea consists of three hollow tines which are connected to the tank by flexible tubing, the feed being by gravity. A strainer must always be used when filling the tank. In this way the liquid manure can be spread in the furrow, so that watering, manuring and tillage are carried on simultaneously. To ensure even distribution, the hermetically closed tank always works at a constant height of liquid. A small liquid manure distributor with two small tines is also made. The liquid manure should be diluted to decrease its alkalinity, with the help of a hygrometer which indicates the approximate content of nitrogen, the content of potash being assumed to be in proportion.

AUTOMATIC UNCOUPLING DEVICE FOR TRACTOR PLOUGHS.—A Wisconsin engineer has patented a design of coupling for mechanical-traction ploughs, by which, when the plough strikes a boulder or other obstacle the engine is automatically stopped, the supply being cut off.

Apple Orchard Pruning Experiments in Vineland, Canada. *R. F. Palmer*, *Agric. Mag. of Canada*.—An experiment consisting of a comparative test of three different pruning treatments, namely—(*a*) Winter or dormant pruning; (*b*) summer pruning; (*c*) no pruning. About fifteen different varieties were under observation.

Results showed that the heavy dormant pruned group made much less growth than either the unpruned or summer pruned trees, and came much later into bearing and with a much smaller yield. It was evident that the lighter the pruning the greater was the growth the earlier the tree came into bearing, and the heavier the yield during at least the early period of the tree's life. Unpruned trees made more growth than those either winter or summer pruned, but in consideration of the increased cost of spraying, picking and growing and the lack of colour and general undesirable condition of unchecked growth, light annual pruning is advised until the tree comes into bearing. After this, more severe pruning may be necessary to maintain a proper supply of new wood each year. This will of course vary with the variety.

The Bee-parasite, Braula.—One of the moderately common denizens of the hive of the honey-bee in this country, as well as in South Africa and elsewhere, is the so-called "bee-louse" (*Braula cæca*). The habit of the adult parasite is fairly well known, the insect being found attached to bees from which in some form or other it absorbs food. . . . It is said particularly to frequent the thorax of bees, and especially to favour queen-bees, on account of the exposed membranes between the body segments which occur in queens. The early life history of *Braula* has not been known with the same certainty as the adult stages. For long it has been thought that the parasite deposited fully formed pupæ, which developed into the perfect insect in some three weeks; but doubt has always attached to this idea. Now the question appears to have been solved, at least so far as South Africa is concerned, by the work of S. H. Skaife, described by him in a recent paper (*Tr. R. Soc.*, *S. Africa*, 1921, *p.* 41). The author says that *Braula* is not pupiparous, but that eggs are laid on the brood combs in the hives, and that the maggots which hatch from the eggs crawl into cells containing young bee larvæ, where they feed on the pollen masses and honey supplied for the young bees. The maggots pupate in the cells in which they fed, but hatch into adults before the immature bees have undergone a similar change. Immediately on emergence the adult Braulas migrate on to the body of a bee. The author states that the adults apparently feed upon honey, and that though the pest seldom becomes abundant in strong hives, in weak hives it may be that scarcely a single bee is to be found without one or more of these parasites attached to it.

OFFICIAL ORDERS AND CIRCULARS.

THE following notices have been issued by the Board to the press :—

Sale of Cereal Seeds.

Seeds Act, 1920.

As there is reason to believe that the requirements of the Seeds Act, 1920, with regard to the sale of cereal seed are not being observed in all cases, the Board of Agriculture for Scotland desire to remind all farmers and seed merchants that by the Seeds (Scotland) Regulations, 1921, the provisions of the Act have been applied to cereal seeds as well as to the principal kinds of other agricultural seeds. On the occasion of a sale of such seeds, a written statement containing certain specified particulars in regard to their quality must be delivered to the purchaser on or before the time of sale or delivery. Any person who fails to comply with the requirements of the Act renders himself liable on summary conviction to a penalty of £5 for the first offence and of £10 for each subsequent offence.

The particulars which must be supplied in the case of a sale of cereal seeds are (*a*) the name and address of the seller ; (*b*) a statement that the seeds have been tested in accordance with the provisions of the Seeds Act, 1920 ; (*c*) the distinctive name of the variety, or if the distinctive name is not known or the stock is mixed, a statement to that effect ; and (*d*) the percentage of germination, provided that if the percentage of germination is not less than the authorised minimum in each case, viz., wheat, 90 per cent., barley, 90 per cent, oats, 85 per cent., rye, 80 per cent., a statement to that effect, which shall include the authorised minimum percentage, shall be sufficient.

All farmers purchasing seed, oats and other cereals for sowing should, in their own interests, insist upon receiving the prescribed declaration from the seller.

General Licence in respect of Sales of Cereals for Seed Purposes.

The Board of Agriculture for Scotland desire to draw the attention of seed merchants and farmers to the general licence which they have issued authorising sellers of seeds of cereals to delay delivery of the declaration of particulars which they are required by the Seeds Act, 1920, and the regulations made thereunder to supply to purchasers of such seed. In terms of the Act this declaration should be supplied to the purchaser on or before the time of sale or delivery of the seed, but the conditions under which the cereal seed trade is conducted are such that during the busiest periods of the season it is frequently impossible for sellers to have a test of a sample of the seed made prior to the completion of the sale. To meet this difficulty, the Board, in exercise of the powers vested in them by the Act, previously issued a general licence, authorising all persons concerned to sell in Scotland, wheat, barley, oats and rye for seed on or before the 30th November of the year in which the seed is harvested without declaring the particulars required by the Act to the purchaser on or before the time of sale or delivery, provided that such particulars should be declared in writing to the purchaser within one calendar month of the sale. This licence has now been extended to apply to sales during the months of March and April of the year following that in which the seed is harvested.

The particulars which sellers of cereal seed are required to declare are as follows—(*a*) the name and address of the seller ; (*b*) a statement that the seeds have been tested in accordance with the provisions of the Act ; (*c*) the distinctive name of the variety, or if the distinctive name is not known or the stock is mixed, a statement to that effect : and (*d*) the percentage of germination provided that if the percentage of germination is not less than the authorised minimum in each case, viz., wheat, 90 per cent., barley, 90 per cent., oats, 85 per cent., rye, 80 per cent., a statement to that effect which shall include the authorised minimum percentage shall be sufficient. All persons who purchase cereal seed during the periods specified, and do not receive a declaration of these particulars on or before the time of sale or delivery should see that it is obtained within at least one month of the sale.

Pure Stocks of Potatoes of the Immune Varieties.

Potatoes.

During the past season, crops aggregating a total area of 28,150 acres were inspected by the Board of Agriculture for Scotland under their scheme for the certification of pure stocks of potatoes of the immune varieties. This represents approximately 50 per cent. of the total acreage of the crops of these varieties grown in Scotland in 1921. The following statement shows the acreages of the different varieties in respect of which certificates of purity were granted:—

	Acres.
Kerr's Pink	6,454½
Great Scot	4,577½
Arran Comrade	2,637¾
Tinwald Perfection	2,070¼
Majestic	1,036¾
Golden Wonder	1,026½
King George	961¾
Lochar	822½
Arran Victory	508½
Abundance types	498
Ally	411½
Langworthy	248
Dargill Early	160¾
Templar	143
Witchhill	121¾
Other varieties	1,009
Total	22,688

A register containing full particulars of the names and addresses of the owners of the respective varieties and acreages of the certified crops has been published, price 2s. (post free). All potato merchants and growers who desire to obtain a copy of the register should apply to the Board of Agriculture for Scotland, 29 St. Andrew Square, Edinburgh.

Silver Leaf Disease of Fruit Tree and Bushes.

Silver Leaf Disease.

The Board of Agriculture for Scotland desire to draw attention of fruit growers to the fact that the pest known as Silver Leaf has now made its appearance in certain districts of Scotland. This disease, which is destructive to fruit trees and bushes, has in recent years caused much damage in the fruit-growing plantations in England, and it is important that prompt and adequate measures should be taken for its eradication before it is allowed to spread in Scotland. The plum tree is highly susceptible to Silver Leaf, but fruit trees and bushes of other kinds are also liable to be effected.

As the name implies, the foliage of trees attacked with Silver Leaf develops a silvery or leaden appearance which generally begins on a single branch. After a time the affected branch begins to die back. As branch after branch becomes infected, large portions of the tree perish, and ultimately and usually the whole tree is killed. The disease is caused by the fungus *Stereum purpureum*, which has developed within the wood of the tree, and only extrudes itself through the dead bark to form external fruiting bodies after the death of a branch. The external fructifications of the fungus are of a purple-mauve colour when fresh, showing often a white or pale woolly margin, and changing colour as they age. From these fructifications innumerable spores are distributed by the wind and gain admission to other trees through wounded surfaces.

Telegrams—"PISCATOR." Telephone 1344 Central.

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SCOTTISH SMALLHOLDERS' ORGANISATION, LTD.

President—Sir HENRY BALLANTYNE, Minden, Peebles.
Secretary and Treasurer—JAMES SCOTT, Esq., S.S.C., 1 Rutland Square, Edinburgh.

Its objects are to assist Smallholders in every way to make the most of their holdings by the adoption of co operative methods. It is non-political and non-sectarian.

It organises Smallholders, of whom there are already 53,000 in Scotland, into Co operative Societies. It has instituted the following Agencies to deal with Smallholders Co-operative Marketing, Banking and Insurance:—

1. **The SCOTTISH CENTRAL MARKETS, Ltd. (Established 1914), which sells produce such as fowls, butter, etc., and buys requirements for Smallholders such as seeds, manures, feeding stuffs, implements, etc.**
2. **The SCOTTISH CENTRAL LAND BANK, Ltd. (Established 1914), which gives Loans to Smallholders, Societies for Agricultural purposes, receives deposits, discount bills, etc.**
3. **The SCOTTISH CENTRAL INSURANCE SOCIETY, Ltd. (Established 1916), which undertakes Live Stock Insurance for Smallholders' Societies, insuring Horses, Cattle, and Live Stock of all classes at low premium.**
4. **The "Scottish Smallholder" paper, Twopence monthly, which is the organ of the whole Co-operative movement in Scotland.**

There is at present no known cure for Silver Leaf, and it is only by the removal of infected trees and the cutting out of "silvered" branches that the spread of the disease can be checked. Wounds made by the removal of branches should be pared with a knife and covered with Stockholm tar.

In view of the seriousness of the disease, particularly in districts where fruit growing is conducted on a commercial scale, the Board have made the Silver Leaf (Scotland) Order of 1922 for the purpose of ensuring that suitable control measures are taken. This Order, which came into operation on the 1st March, requires occupiers of premises in which plum trees are growing to cut off and destroy by fire on the premises all dead wood on each plum tree before the 1st of April of each year. Where the dead wood extends to the ground, the whole tree, including the roots, must be burned. Notices may also be served under the Order requiring the destruction of any dead wood of any tree or bush on which there are visible fruiting bodies of the fungus *Stereum purpureum*. Copies of the Order can be obtained from His Majesty's Stationery Office, 25 Forth Street, Edinburgh. Price 2d. each, post free.

Fruit growers desiring further information regarding the disease should communicate with the Secretary, Board of Agriculture for Scotland, 29 St. Andrew Square, Edinburgh.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in December 1921 and January and February 1922.

Average Prices of Live Stock in Scotland.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December			January			February		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd.	3rd
Fat Stock —									
Cattle—	per cwt l w s d	per cwt l w s d	per cwt l w s d	per cwt l w s d	per cwt l w s d	per cwt l w s d	per cwt l w s d	per cwt l w s d	per cwt l w s d
Aberdeen Angus	72 1	63 3	43 7	70 1	63 6	45 0	69 4	61 9	46 2
Shorthorn	68 6	62 0	46 3	65 9	61 9	49 0	65 3	60 9	48 6
Galloway	61 3	56 3	51 9	60 3	56 0	49 0	60 6	57 9	
Ayrshire		53 3	20 6		53 0	21 6		55 4	23 4
Cross bred	67 4	59 4	42 4	66 4	59 5	44 0	66 3	59 7	44 6
Blue Grey	62 0	57 0	52 0	60 3	56 0	49 0			
Highland	63 0	60 0	40 0				65 0	59 0	
	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d	per lb d
Veal Calves	20½	11	8¾	22¼	11¾	9			
Sheep—	under 60 lb. per lb d	60 lb and upwards per lb d	Ewes per lb d	under 60 lb per lb d	60 lb and upwards per lb d	Ewes per lb d	under 60 lb per lb d	60 lb and upwards per lb d	Ewes per lb d
Cheviot	14	13	10¼	14¼	13¾	11¼	16	14¼	12¾
Half-bred	13¼	12½	9½	14½	13¼	10¼	15¼	14¼	14
Blackface	12¼	11	9½	14	12¾	10½	15½	14½	12
Greyface	13¾	12¼	9¾	15	13½	10½	16	14½	14
Down Crosses	13¾	12¼		15	14		15½	14½	
Pigs—	per stone s d	per stone s d	per stone s d	per stone s d	per stone s d	per stone s d	per stone. s d	per stone s d	per stone s d.
Bacon Pigs	13 1	11 3	9 0	13 7	11 5	10 8	14 0	12 4	11 9
Porkers	13 4	11 11	9 0	13 11	12 2	10 8	14 6	12 10	11 9

Average Prices of Live Stock in Scotland—*continued*

Description	December						January						February					
	1st		2nd		3rd		1st		2nd		3rd		1st		2nd		3rd	
STORE STOCK—																		
Store Cattle—	per head		per head		per head		per head		per head		per head		per head		per head		per head	
	£	s	£	s	£	s	£	s	£	s	£	s	£	s	£	s	£	s
Aberdeen Angus																		
Yearlings	18	7	15	9	12	0	21	17	16	15	13	7	22	19	17	17	13	1
Two year olds	29	13	23	7	16	0	30	1	22	13			30	5	24	5	17	0
Shorthorn																		
Yearlings																		
Two year olds																		
Galloway																		
Yearlings			14	13	11	7	17	15	14	10	12	0	15	5	12	10		
Two year olds			22	0	18	0							19	5				
Ayrshire																		
Yearlings																		
Two year olds																		
Cross bred																		
Yearlings	17	5	14	10	12	12	17	5	15	17	10	16	17	5	15	14	10	15
Two year old	20	11	21	1	17	5	26	2	20	17	15	5	27	10	25	0	17	0
Blue Grey																		
Yearlings							14	15										
Two year olds							19	0										
Highland																		
Yearlings	13	18	11	15	7	5												
Two year olds	24	5	17	7	11	16												
Three year olds			18	10														
Dairy Cows—																		
Ayrshire																		
In Milk	45	4	31	1	19	13	37	2	25	4	16	0	36	0	22	10		
Calvers	45	12	30	10	20	6	36	16	26	1	18	4	37	8	22	10	17	0
Shorthorn Crosses																		
In Milk	49	3	37	15	25	5	45	12	35	12	23	16	42	17	30	15	21	1
Calvers	47	6	33	15	23	18	43	0	30	8	20	19	42	0	29	14	19	18
Store Sheep—																		
	s	d	s	d	s	d	s	d	s	d	s	d	s	d	s	d	s	d
Cheviot Hoggs	39	0					54	0	38	0								
Half bred Hoggs	51	0	42	0			61	3	51	0					57	6		
Blackface Hoggs			32	0	24	6	39	3	32	10	25	0			52	0	24	8
Greyface Hoggs	46	0	39	0	34	0	47	0	40	2	31	0	47	10	41	6	31	6
Store Pigs—																		
(6 to 10 weeks old)	37	1	24	9			39	1	23	5			52	10	29	5		

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	December.			January.			February.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
BEEF :—Home-fed—										
Bullock or Heifer ..	1	10½	10¼	12	10¾	11⅛	11¾	10½	11⅝	12
	2	9½	8¾	10⅞	10⅛	9⅝	10¾	10	9⅜	11
Bull	1	9⅛	8⅜	8⅜	9⅝	8⅛	8¾	9	9	8½
	2	8¼	7¼	7⅝	8⅝	8⅛	7⅞	8	8	7½
Cow	1	7	7¼	7½	7½	7¾	8⅛	7¼	7⅜	7⅝
	2	6	6½	6¾	6½	7	6¾	6¼	6⅛	6⅞
Irish—										
Bullock or Heifer ..	1	...	...	9½	...	...	9¾	...	...	10
	2	...	...	9	...	...	9⅛	...	..	9
Bull	1	...	...	7½	...	...	7⅞	...	..	7⅝
	2	...	...	6⅝	...	...	7	...	...	6⅞
United States and Canadian Killed at Glasgow ...	1	..	..	..	...	...	9¾	...	...	...
	2	...	...	.	...	...	9	...	...	...
Argentine Frozen—										
Hind Quarters ...	1	...	7	6⅜	...	6⅜	6⅛	...	6	5¾
Fore ,, ...	1	...	4¾	4⅜	...	4¼	3⅞	...	4	3½
	2	..	..	4⅛	...	...	3⅝	...	...	3¼
Argentine Chilled—										
Hind Quarters ...	1	...	7¼	6½	...	6¾	6¾	...	6⅛	5⅞
	2	...	...	5½	...	...	6¼	...	...	5½
Fore ,, ...	1	...	4⅜	4⅛	...	4	3⅞	...	3¾	3⅝
	2	...	...	...	...	..	3½	...	...	3⅜
New Zealand Frozen—										
Hind Quarters ...	1	...	...	5¼	...	...	5¼	...	...	...
Fore ,, ...	1	...	...	3⅞	...	...	3¾	...	..	3¼
	2	...	...	3¾	...	...	3½	...	..	...
Australian Frozen—										
Hind Quarters ...	1	...	..	5½	...	...	5⅛	...	...	...
	2	...	...	5⅜	..	...	...	...	..	...
Fore ,, ...	1	...	...	4⅜	...	...	3¾	...	...	...
	2	...	...	3⅞	...	...	3½	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	12¼	11¾	12⅜	13¾	13	14¼	14¼	14	15⅜
	60 lb. and over.	11¼	10⅜	11½	12¾	12¼	12¾	13	13¼	14¾
,, Cross	under 60 lb.	12½	12¼	12⅜	14¼	13¾	14¼	14¾	14¾	15⅜
	60 lb. and over.	11½	11⅛	11½	13¼	13	12½	...	13¾	14¾
Ewes, Cheviot ...	1	9½	9¼	9⅜	10¼	10	10½	12	11⅞	13⅞
	2	8½	...	8⅞	9½	...	9¾	11	...	13⅛
,, Blackface ...	1	9⅜	...	9¼	11	...	10⅛	12½	...	13⅞
	2	8⅝	...	8¾	10	...	9¾	11½	...	12⅞
,, Cross	1	8½	8½	9¼	10	9½	10½	11½	10¼	13⅞
	2	7½	...	8¾	9	...	9¾	10½	...	12¾
Argentine Frozen ...	1	...	5¾	5⅝	...	6½	6	...	8⅜	7⅜
	2	...	5½	5	...	...	5½	...	...	7
Australian ,, ...	1	...	...	5⅛	...	...	5¾	...	...	7¼
	2	...	...	4⅝	...	..	5½	...	...	7
LAMB :—Home-Fed ...	1	12½	...	12⅝	14½	...	14	...	...	...
	2	...	...	12½	...	...	...	...	...	...
New Zealand Frozen	1	...	9⅞	8½	...	9½	9¼	...	11⅛	10¾
	2	...	...	7½	...	.	8¼	...	...	...
Argentine ,, ...	1	...	6	6¼	..	...	5¾	...	...	..
	2	...	...	5¾	..	...	5½	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market ~~Reporter~~.)

Description.	Quality.	December.		January.		February.	
		s.	d.	s.	d.	s.	d.
BUTTER:							
Irish Creamery... per cwt.	1	178	6	150	0	...	
	2	170	0	...		...	
,, ,, (Unsalted) ,,	1	186	6	160	0	...	
Canadian ... ... ,,	1	154	3	120	0	122	0
,, (Unsalted) ,,	1	192	0	...		...	
Danish ... ... ,,	1	182	6	168	9	180	6
,, (Unsalted) ,,	1	185	0	160	0	...	
Australian ... ... ,,	1	143	6	119	6	131	0
,, (Unsalted) ,,	1	149	6	130	0	142	6
New Zealand ... ... ,,	1	162	6	134	3	146	0
,, (Unsalted) ,,	1	176	0	162	0	165	0
Argentine ... ... ,,	1	140	9	111	6	116	0
,, (Unsalted) ,,	1	167	3	136	3	132	0
CHEESE:							
Cheddar ... ... ,,	1	110	0	104	0	112	0
	2	97	0	92	6	101	0
Cheddar Loaf... ... ,,	1	130	0	122	6	123	0
	2	...		112	0	114	0
Dunlop ... ... ,,	1	105	0	99	6	107	6
	2	94	0	88	0	97	0
Canadian ... ... ,,	1	106	6	99	6	105	0
	2	101	0	93	0	99	6
New Zealand ... ... ,,	1	...		91	8	102	6
	2	...		87	4	96	0
BACON:							
Ayrshire (Rolled) ... ,,	1	167	6	164	0	164	0
Irish (Green) ... ... ,,	1	148	0	148	0	149	0
,, (Dried or Smoked) ,,	1	160	0	160	0	163	0
,, (Long Clear) ... ,,	1	149	6	146	6	146	6
Wiltshire (Green) ... ,,	1	148	0	148	0	149	0
,, (Dried or Smoked) ,,	1	160	0	160	0	163	0
American, Long Clear Middles (Green) per cwt.	1	101	0	94	0	110	6
American, Short Clear Backs ... ... ,,	1	88	0	86	0	97	6
BACON (continued):							
American Sides ... ,,	1	80	0	80	0	105	0
	2	70	0	70	0	70	0
,, Cumberland Cut ,,	1	88	6	84	0	101	0
	2	80	0	80	0	83	0
Canadian, Sides ... ,,	1	121	3	120	0	130	0
Danish, Sides ... ,,	1	144	0	144	0	142	0
HAMS: Irish (Smoked) ,,	1	196	0	188	6	181	6
American, Long Cut ,,	1	114	9	108	9	125	6
,, (Green)... ,,	2	104	8	98	9	123	6
,, Short Cut ,,	1	123	9	119	6	133	3
	2	...		...		130	0
Canadian, Long Cut ,,	1	117	6	112	0	126	0
	2	...		103	0	121	0
EGGS: Country ... per doz.	1	4	7	3	11	4	1
	2	4	5	3	9	3	11
Irish ... ... per 120	1	41	0	32	0	33	0
	2	39	0	30	9	31	9
,, (Cold Stored) ,,	1	40	0	26	6	...	
,, (Duck) ... ,,	1	38	9	33	4	34	3
	2	...		30	0	...	
American ... ... ,,	1	23	11	22	10	...	
Canadian ... ... ,,	1	28	0	25	9	...	
	2	26	5	24	6	...	
Argentine ... ... ,,	1	25	1	22	4	21	6
	2	23	9	21	0	20	0
Danish ... ... ,,	1	42	9	32	3	35	0
	2	40	9	30	9	34	0
,, (Pickled) ... ,,	1	25	3	22	3	20	0
Roumanian ... ,,	1	23	8	22	7	22	0
,, (Pickled) ,,	1	17	0	16	8	...	
Moroccan ... ... ,,	1	19	0	...		18	0
Polish ... ... ,,	1	21	0	21	3	20	6
Lithuanian ... ,,	1	23	8	22	1	21	0
Egyptian ... ... ,,	1	15	8	13	1	16	6
	2	...		12	9	15	0

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters*)

Markets.	Quality.	Second Earlies.	Late Varieties. Red Soils. Langworthy.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy	Late Varieties. Other Soils. Other.
		per ton £ s d.	per ton £ s. d.	per ton £ s d	per ton £ s d.	per ton £ s. d.
		DECEMBER.				
Dundee ..	First .	4 15 0	..	.	...	5 15 0
	Second ...	...	..	.	.	..
Edinburgh . ..	First .	5 0 0	9 0 0		0 0 0	5 0 0
	Second ..	.	..		...	
Glasgow .	First .		10 0 0	.	..	5 7 0
	Second .	...	..	.	..	...
		JANUARY.				
Dundee . ..	First ..	4 15 0	..	...	.	6 7 6
	Second .	...	..	...	...	...
Edinburgh .. .	First ..	5 7 6		.	.	5 7 6
	Second .	...	...	...	..	...
Glasgow	First ...	...	...	..	...	5 7 9
	Second ...	...	...	..	..	...
		FEBRUARY.				
Dundee	First .	5 15 0	...	...	...	7 1 3
	Second ...	...	..	...	...	...
Edinburgh	First ..	...	...	...	...	6 5 0
	Second ...	...	...	...	...	...
Glasgow	First ...	...	10 10 0	...	...	5 15 0
	Second ...	...	...	...	...	...

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters*).

Markets.	Quality.	Roots.			Hay.		Straw.			Moss Litter.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Barley.	Oat.	
		per ton. s. d.	per ton. s. d.	per ton s. d	per ton. s. d	per ton. s. d.	per ton. s. d	per ton s. d	per ton. s. d.	per ton. s. d.
					DECEMBER.					
Dundee ...	1	...	22 10	25 10	135 7*	...	83 4*	...	89 4*	..
Edinburgh	1	...	...	...	125 7†	...	51 10†	...	50 7†	...
	2	...	...	...	80 0†	..	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	38 9
					JANUARY.					
Dundee ...	1	...	22 8	25 10	138 1	...	90 0*	...	93 0*	...
	2	...	...	...	...	...	...	...	90 0	...
Edinburgh	1	...	...	...	126 3†	...	52 6†	...	52 6†	...
	2	...	..	..	83 1†	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...		...	..	37 6
					FEBRUARY.					
Dundee ...	1	...	18 0	23 0	140 0*	...	91 3*	..	102 6*	...
Edinburgh	1	...	...	...	130 0†	...	64 4†	50 0†	69 4†	...
	2	...	...	...	92 6†	...	...	...	...	...
Glasgow ...	1	...	...	...	...	..	...	...	...	37 6

* Price for Hay and Straw baled and delivered.

† Price for Hay and Straw delivered loose in town.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters)

Description.	December.						January.						February.					
	Glasgow.			Leith.			Glasgow.			Leith.			Glasgow.			Leith.		
	per ton.			per ton.			per ton.			per ton.			per ton.			per ton.		
Linseed Cake --	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
*Home	15	0	0	14	17	6	15	0	0	14	17	6	17	0	0	16	6	10
Undecorticated Cotton Cake—																		
Bombay (Home-manufactured)	...			9	2	6	...			8	11	3	9	0	0	8	12	6
Egyptian (Home-manufactured)	11	0	0	...			10	10	0	...			10	0	0	...		
*Palmnut Kernel Cake	...			8	10	0	...			8	10	0	...			8	10	0
Bean Meal ...	12	10	0	12	10	0	13	0	0	12	10	0	13	10	0	12	10	0
Maize	‡8	0	0	8	5	0	‡7	16	10	8	5	0	‡8	0	0	8	10	0
Maize Meal ...	9	10	0	9	5	0	9	2	6	9	5	0	9	5	0	9	10	0
Maize Gluten Feed (Paisley)	8	10	0	...			8	8	9	...			8	12	6	...		
Maize Germ Meal	...			11	10	0	...			11	10	0	...			11	10	0
Maize Germ Cake Meal	12	0	0	...			12	0	0	...			12	17	6	...		
Rice Meal... ...	...			...			...			...			8	0	0	...		
Locust Bean Meal	...			8	5	0	...			8	0	0	...			8	0	0
Maize Germ Cake	...			...			12	12	6	...			12	6	3	...		
Barley (Feeding)...	9	10	0	9	0	0	9	10	0	9	0	0	9	15	0	9	0	0
Oats, Canadian ...	10	11	3	...			10	11	8	...			10	8	9	...		
„ Home ...	10	7	6	9	0	0	10	17	6	8	16	3	10	12	6	8	15	0
*Malt Culms	6	6	3	5	17	6	6	3	9	6	0	0	6	10	0	6	5	0
Distillery Mixed Grains--																		
Dried	9	10	0	9	0	0	9	15	0	9	0	0	9	15	0	9	0	0
Wet	...			1	15	0	...			1	15	0	...			1	15	0
Brewers' Grains--																		
Dried	8	13	9	8	0	0	8	15	0	8	0	0	8	15	0	8	0	0
Wet	...			1	15	0	...			1	15	0	...			1	15	0
Wheat --																		
†Middlings (Fine Thirds or Parings)	10	7	6	10	1	3	10	0	0	9	15	0	9	13	9	8	18	9
Sharps (Common Thirds)	9	5	0	...			9	5	0	...			9	2	6	...		
†Bran (Medium) ...	10	0	0	9	17	6	9	18	9	9	17	6	9	6	3	9	1	3
Feeding Treacle ...	7	6	8	7	17	6	7	15	0	7	10	0	7	15	0	7	10	0
Crushed Linseed ...	...			28	0	0	...			28	0	0	...			28	0	0
Fish Meal... ...	15	7	6	15	10	0	15	10	0	15	10	0	15	6	8	15	10	0

* Price of bags and authorised transport charges are not included.

† Price of sacks included. ‡ American corn.

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FARM PESTS.[1]

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The Origin of Pests.—Agriculture has, in a sense, created its own pests, and the progress of agriculture implies that agricultural pests will increase in number and in the intensity of their attacks. For the amount of animal life in a country depends upon the extent of the food supply, so that in a country untouched by man a more or less stable balance is ultimately reached between the total amount of plant growth and the creatures which subsist upon it, whether they make use of it directly, like the herbivorous animals, or indirectly, like the creatures of prey which feed upon the grass-eaters. Further, since "all flesh is grass" in the sense that all animals, carnivorous and herbivorous alike, depend in the long run upon the vegetation of the earth for sustenance, a new significance attaches to those processes of husbandry whereby two blades of grass are made to spring where nature originally grew only one, for the increase inevitably involves also an increase of animal life. It follows, therefore, that when man, by the successes of his intensive cultivation, increased the total amount of plant growth, he created an increased potential food supply for wild grass-eaters as well as for his domestic animals; and when he continued to increase his flocks and herds, by supplying new food obtained by means of his cultivation, he offered a fresh opportunity for the increase of beasts and birds of prey.

Pests, then, arose only as man gave them opportunity. But their development was a gradual process and followed on each advance of husbandry. In the early days of savagery, when man was scarcely more than a wild creature himself, there was little enmity between him and the beasts. True, he contended with them for his safety and for his food in the far-off times when

> "The sad barbarian, roving, mixed
> With beasts of prey, or for his acorn meal
> Fought the fierce tusky boar,"

but the fight was almost on equal terms, and it bred no vindictiveness. It was only after man had domesticated certain animals, and when the nomadic tribes-man, ignorant of cultivation, began to increase his flocks and herds by the simple expedient of driving them to fresh feeding grounds, that the beasts of prey, first of all, came to be looked upon as essential enemies of welfare and of the accumulation of agricultural wealth.

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[1] This article is the first of a series dealing with animal pests. A series on "Common Weeds" appeared in this *Journal* from January 1921 to January 1922 inclusive.

A second stage in the development of pests was entered upon when the nomad forsook his wandering ways and settled down as a tiller of the soil. Then he encouraged the wild grass-eaters, and the hordes of insects which at one stage or another depend upon plant life, to increase in numbers, so that they also in their multitudes entered the realm of pests. And, finally, as I have indicated, each improvement in cultivation implied an increase in domestic stock, and this again gave new strength to the armies of predatory beasts and birds.

It is important to remember, however, that in the natural order of things the increase of any animal is met by the development of natural enemies which eventually restore a working balance of numbers. Man's interference does not annul this natural order, but it seriously loads one scale of the balance; so that it might be said that the degree in which a creature *remains* a pest corresponds to the excess of the effects of man's intensive cultivation over the restorative power of nature. Just because man's methods are more rapid than nature's, nature is unable to cope with the pests he creates; and so it comes to be that, if crops and domestic stock are to survive for man's use, he himself must take part in the warfare against pests, and I am not sure that, where the method can be put into practice, he can do better than aid nature by adopting her own ways.

Degrees of Harmfulness.—Pests vary not only in kind and in the manner in which they set to work, but they also exhibit varying degrees of pestilence; and these degrees are of some importance in settling the seriousness and the persistence of the efforts to be made to keep them in check. Some pests do harm almost from the day of their birth till the day of their death—the rabbit might be cited as an example, and such pests deserve no respite. Others are actively harmful only at one stage of their existence, and are neutral or harmless at others; such are many insects, which in the larval grub or caterpillar stage, may be exceedingly destructive, but in the pupa and imago stages are innocent of damage. These also deserve no truce; and it is important to remember in dealing with them that hostility need not be confined to the harmful stage, and that another and perhaps very dissimilar stage may be most vulnerable. For this reason a thorough knowledge of the life-histories of pests is essential to the discovery of the most effective remedies. Lastly, a third group of pests may be actively harmful at one stage and actively beneficial at another—many grain-eating birds, even sparrows, destroy large numbers of injurious insects during the period when they are feeding their young. Others, and the rook is an example, do good and evil almost simultaneously.

While, therefore, some pests may easily be labelled as such, in the case of others, it is not an easy matter to decide whether the balance veers to good or evil, and only a careful scrutiny of the facts can help to a just estimate. It is not enough to be able to say that a bird or beast does harm ; it may be that in spite of this it does more good than harm, and ought to be left alone or even protected.

Even if, after a careful scrutiny of all the facts, it has been decided, in a general way, that the balance of evil lies against some specific pest, other factors may complicate the question. It frequently happens that an animal is not an universal pest, equally destructive and equally to be destroyed in every part of its range. Two influences which contribute largely to the agricultural standing of such pests are the numbers of the creature itself, and the agricultural character of the district in which it occurs. In moderate numbers some animals, let us say rooks and gulls, may be harmless or may be actively beneficial ; but where, owing to an increase of numbers, competition compels such creatures to augment their diet of injurious insects by turning to corn, potatoes or turnips, the balance may change over, and the helper become a hinderer. In Cornwall ravens are a treasure, in Argyllshire a pest. Or the agricultural character of the area may be a determining factor. The farmer, by offering an abundant and easily obtained food supply, may induce creatures to forsake their original food, and to develop tastes to his hurt ; as the Colorado beetle did when it gave up the wild sand bur of the Rocky Mountains to devastate the potato crop from Missouri to the Atlantic sea-board. In our own country a blackbird may do nothing but good in an arable area, but in a fruit-growing district it is anathema ; starlings do great service in a pastoral country, in a corn-growing land they do great damage.

All such difficulties of place and time and numbers contribute to make a hard and fast classification of pests an impossibility. The best that can be done is to consider the position of each kind, to discover it's true place in the economy of the farm, to condemn it universally if it be found to be a serious and universal pest, to draw attention to its varying habits if it be no more than a local or occasional pest, and to discover the weak points in its armour, where it may most readily and effectively be attacked. These articles, then, will endeavour to place before the reader, in brief, a balanced account of the activities, good and bad, of each potential pest, a tracing of the life-history in so far as it affects crops or affords opportunity for successful attack, and a statement of the remedies which have been tried and have been found to be of greatest service in overcoming crop-damage or controlling the number of pests.

THE LARGER PESTS.

For convenience of treatment, and because the creatures themselves stand in very different categories as regards their methods of doing damage, as well as regards the methods to be adopted against them, farm pests are here grouped roughly into the wide series—the larger pests and the smaller pests. The former include the mammals and the birds, the latter the insects and others of the great series of invertebrate or back-boneless animals.

The larger pests are, because of their size and commonness, for commonness is of the essence of a pest, probably the most familiar of our wild creatures. The majority are well known, and there are few that are not recognisable at first glance. No words, then, need be wasted in describing their external appearance, except in the case of the more obscure creatures, such as voles, field-mice and shrews.

It is in connection with the larger pests only that those violent conflicts of interest arise, which render impossible the single-minded treatment which agricultural interests by themselves would demand. The conflict centres in the oftentimes opposing influences of game-preservation and crop-protection; and it may be a matter of old-established game laws, which may grant protection to animals even when and where they are known to do damage, or of bias determined by the predominant idea of protecting either game or crops. Such difficulties will be referred to each in its proper place.

It should be noted further that, in this country, so far, only the larger pests have been the subjects of laws specially devised for the protection of the farmer's property and produce. This legislation, mostly of very recent date, will also be referred to in its proper place.

In these articles the mammal and the bird pests will be considered separately, and an endeavour will be made to classify each series into groups, according to the nature of the damage done.

(a) *Mammal Pests.*

(1) DESTROYERS OF FARM STOCK.—The destroyers of stock in Britain belong, without exception, to the order of the carnivorous animals, and it is matter for congratulation from the farmer's point of view, that owing to the strenuous endeavours of many centuries, the carnivores of Britain have been reduced almost to negligible proportions. In the United States of America, at the present day, the annual amount of damage caused to domestic stock by predatory animals, wolf, mountain lion, coyote, lynx and bear, is reckoned at $20,000,000 to $30,000,000; and a proportionate loss must have been caused in Scotland in the days when the European lynx, the brown bear and the wolf ravaged the land. Even as late as the sixteenth century, Hector Boece reminds us that "The wolffis ar richt noisum to the tame bestiall, in all partis of Scotland" (1527); and half a century later, Bishop Leslie found no diminution of the plague: "Our nychbour Inglande has nocht ane wolfe, ... but we now nocht few, ye contrare, verie monie and maist cruel, chieflie in our North country, quhair nocht only invade thay scheip, oxne, ye and horse, but evin men." But the

lynx and the brown bear are long extinct in the land, and merciless persecution had practically stamped out the wolf before the opening of the eighteenth century, leaving the farmer of to-day to contend merely with a miserable remnant of a once prolific carnivorous fauna.

The Fox.—The native foxes of Britain belong to a race (*Vulpes vulpes crucigera*) which occurs throughout Central and Southern Europe. In Scotland foxes are universally distributed in both the Lowlands and Highlands of the mainland, but are absent from the islands except Skye; the somewhat larger and longer-limbed individuals of the hill country are often known as "greyhound foxes," the shorter-limbed individuals of the Lowlands as "terriers." Their distribution is, however, by no means uniform throughout the land for, while they are moderately common in the Lowland and Midland counties, where they are preserved, they have become numerous in many of the wild deer forests, where they perform useful service in keeping down birds which disturb the quarry, but have almost disappeared on some grouse moors and cultivated areas where they are most harmful.

THE FOX.

The most troublesome of Scotland's predatory animals.
(From Bell's *History of British Quadrupeds.*)[1]

As a rule, the fox hunts singly and at night, and by day seeks shelter in a burrow or "earth;" but, especially if its feeding ground be far from its burrow, it may spend the night in any convenient thicket, or amongst stones or rocks on a hill-side, or even in deep heather. The burrow is nursery as well as shelter, and there, in March or April, the young, usually three or four but sometimes five in a litter, are born.

Economic Significance.—From the farmer's point of view the fox has good as well as evil attributes. In many areas its food consists of rabbits, leverets and even rats and field-voles, and especially when the vixen is foraging for her cubs, the destruction of these farm pests is of very considerable service. In places skirting the seashore, where it feeds partly on marine creatures, such as crabs and molluscan shell-fish, as well as on occasional fishes, its activities may also be harmless.

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[1] The blocks of the illustrations in this article were kindly lent by Messrs Gurney & Jackson, Edinburgh and London.

On the other hand as a destroyer of game the fox is only too well known, for sitting partridges and pheasants form an easy prey, and on grouse moors the damage done to the birds is so great as to have led to the persistent persecution, even to extermination, of the forager. The stock of the farmer does not escape, and the wiles by which reynard finds access to and escapes from the poultry yard are as various as they are cunning. Most serious of all are its attacks on lambs on hill sheep farms. The annual damage to flocks is very great, and even in earlier times, when sheep were less common than now, it led to the fox being coupled with the wolf in Scottish law, as a prime destroyer of domestic stock. The seriousness of the fox's misdemeanours is intensified by the fact that, when opportunity offers, it kills wantonly, far beyond the need of the moment. It is on record that as many as twenty brace of grouse, besides hares, rabbits and two lambs have been found at the den of a single hill fox.

Out of twenty-one Scottish counties from which complaints regarding agricultural pests have been received by the Board of Agriculture for Scotland, seventeen mention the fox as destructive.

Methods of Destruction.—In counties where fox-hunting prevails, foxes are preserved, but as a rule their numbers are kept within reasonable limits and compensation is made to farmers for damage caused to stock. In other areas, and particularly in the neighbourhood of the northern hill farms and grouse moors, foxes are looked upon as vermin to be destroyed in any possible way. From the thirteenth till the eighteenth century, it was the custom in Scotland to employ district fox-hunters whose duty it was to keep in check the foxes in the region assigned to them. The intensive destruction that resulted, combined with the earlier method, encouraged and enforced by law and by the terms of leases, whereby common effort was organised on the part of the inhabitants of a parish or similar area, produced good results. In five contiguous parishes on upper Deeside in Aberdeenshire, in the ten years beginning with 1776, 634 foxes were accounted for, and in seven years from 1819, 546 were killed on a couple of estates in Sutherlandshire. The increase of foxes in outlying districts in recent years, has again brought about concerted action in parts of Aberdeenshire, with most excellent results, and no better method could be recommended for the reduction of the numbers of foxes where they have become troublesome; for the fox is a wide forager and makes a practice of killing in districts far removed from its permanent abode, so that isolated endeavour, which is bound to be confined to a strictly limited area, runs great risk of proving to be only a mediocre half-measure.

The method of destruction most favoured to-day is trapping, and the trap generally used is some type of "gin," baited with rabbit or hare, or better still, it is said, with the entrails of a sheep. A writer in the *Field* not long since recommended that the bait and trap should be placed on a narrow pier jutting out into pond or stream, so that, even if it were not securely caught, the fox might be destroyed by drowning. Other methods employed are shooting, driving woods and coverts with beaters and placed guns, and the annual clearing of the dens during the breeding season in spring time, when, with the aid of terriers and guns, both vixen and cubs may be caught. The cubs are sometimes kept alive in order to supply the steady demand for such from English hunting districts. In France, where in some parts the war against foxes is intense and continuous, in addition to the methods above mentioned, foxes are often shot at live or dead baits, are asphyxiated in their burrows by sulphur cartridges (a method capable of much development since the experiments with poison gas made during the Great War), and poisoned, one of the best baits being a dead cat dosed with strychnine.

PINE MARTEN.

Once a serious farm-yard pest in Scotland, now approaching extinction.
(From Bell's *History of British Quadrupods.*)

Wild Cat, Pine Marten and Polecat.—These, the remaining carnivores which may be reckoned as agricultural pests, have become so reduced in numbers during the last century, partly by misadventure, mainly by persecution, that they have for practical purposes dropped out of the farmer's vermin list. All were, however, at no distant date, widely distributed in the country; in Aberdeenshire, in five parishes about Braemar, forty-four wild cats were killed in the ten years following 1776; in the three years, 1831 to 1834, 901 wild cats, martens and foumarts (or polecats) were killed on the Duchess of Sutherland's estates in Sutherland;

and as late as 1831, as many as 600 skins of the polecat were on sale at Dumfries Annual Fur Fair.

Whenever any of these creatures took up their habitation in the neighbourhood of a farm-yard, serious depredations were sure to follow. The pine marten, even in recent years, has been alleged to have been guilty of killing lambs in northern Scotland; but Macgillivray's account of the habits of the polecat gives a more general picture of their activities: "It sometimes commits great depredations among the poultry, sucking the eggs, and killing the chickens, grown-up fowls, and even turkeys and geese. Not satisfied with obtaining enough to allay its hunger, it does not intermit its ravages until it has destroyed all within its reach . . . . Its ferocity, cunning and extreme agility, render it a great enemy to game of all kinds; and it destroys the eggs of pheasants, grouse and partridges, seizes the birds on their nests, pursues rabbits . . . . and frequently seizes on young hares."

Nowadays the wild cat, marten and polecat, are confined to the wilder regions of northern and western Scotland, where their limited numbers increased to some extent during the years of the Great War, but where they have since suffered renewed persecution. It is very unlikely that the opportunity will ever be given them of so increasing in numbers and extending their range as to become again serious farm pests.

Other carnivores of agricultural interest are the stoat, the weasel and the badger; these will be referred to in a subsequent section.

THE IMPORTANCE OF MINERAL MATTER FOR GROWING ANIMALS.

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THE amounts of the different minerals in feeding-stuffs have been studied chiefly with reference to the loss of them from the soil in growing crops and with their return to the soil in the manure. With regard to animals, the nutritive value of foods is usually calculated from their protein content and their fuel or "starch value," the mineral matter being often dealt with under the heading of "manurial value."

This disregard of the nutritive value of mineral salts to animals is due to an assumption that any mixture of ordinary feeding-stuffs with the occasional addition of common salt will yield a sufficiency of all the minerals known to be essential to health. While this may be true within limits for animals that have reached maturity, it is far from being true in the case of those that are growing.

If we take the two minerals required in largest amounts, viz., lime and phosphorus, and consider what quantities of these are needed, and to what extent they are present in the most commonly used foodstuffs, the importance of considering the mineral requirements of growing animals becomes at once evident.

The Lime and Phosphorus Requirements of Growing Animals.—Calcium and phosphorus form essential constituents of all the tissues of the body. They are present in largest amounts in the bones, of which together they constitute about half of the total weight. Taking the whole animal, lime (as CaO) is present in the bodies of cattle to the extent of 1·5 to 2·0 per cent. and of store pigs to 1·0 per cent. Phosphorus (as P_2O_5) is present in slightly less amounts. Hence in these animals, for every 100 lb. increase in weight throughout the whole period of growth, the calf requires 1½ to 2 lb. and the pig 1 lb. of each of these minerals as constructive material.

In estimating the amounts of lime and phosphorus required, it must be kept in view that, of what is eaten, only a percentage is absorbed and retained. To cover the loss through failure to assimilate all that is present in the food, and the loss in the excreta of part of what has been assimilated, a young growing animal needs to receive in the food probably about twice as much as is required for constructive purposes.

On this basis, a calf putting on a pound of weight a day and consequently requiring about a third of an ounce of each of these minerals as constructive material, would require at least two-thirds of an ounce of each in the food, and by the same method of estimation, a pig making the same daily gain in weight would require rather more than a third of an ounce of each in the food.

These amounts seem very large, but the theoretical considerations on which they are based are confirmed by experimental evidence. The following results of an experiment on a pig four months old show the actual amounts that can be retained by a growing animal.

The pig was confined in a metabolic cage where the fæces and urine could be collected separately. The amounts of calcium and phosphorus were determined in (*a*) the intake in the food eaten, and (*b*) the output in the fæces and urine. The following table shows the amounts retained per day. The figures are stated in grams (28 grams = 1 oz.) and are the averages for a period of five days.

	Intake in food.	Output.			Amount retained.
		Fæces.	Urine.	Total.	
Lime (CaO) . .	8·47	2·05	0·21	2·26	6·21
Phosphorus (P_2O_5) .	13·14	3·75	1·35	5·10	8·04

Even in confinement in a cage where the conditions for maximum growth were unfavourable, the pig retained and built into its tissues 8·04 grams phosphorus (as P_2O_5) per day and 6·21 grams of lime (as CaO).

The requirements of these elements of course vary with the rate of growth. Assuming that half of what is present in the food is retained, the calf should have in the food a supply of each of the minerals equal to at least 3 per cent. of the increase in weight and a pig a supply equal to 2 per cent.

Kellner has estimated that a calf should receive 21 grams (two-thirds of an ounce) of lime (CaO) and 28 grams (1 ounce) of phosphorus (P_2O_5). From the foregoing considerations a pig four months old should have from a third to a half ounce of each per day.

Lime and Phosphorus in Feeding-Stuffs.—Let us consider now how such relatively large amounts of these two essential minerals can be supplied by the common feeding-stuffs.

The following table gives an indication of the average percentage of protein, total mineral matter (the ash) and lime and phosphorus per 100 parts of several animal products, grains and fodders.

PROTEIN AND MINERAL COMPOSITION OF SOME FEEDING-STUFFS. PER 100 PARTS.

		Protein.	Total Ash.	Lime (as CaO)	Phosphorus. (as P_2O_5).
Animal Products	Milk—Cow's	3·50	0·74	0·17	0·22
	Milk—Sow's	7·25	1·09	0·41	0·35
	Fish Meal	61·00	23·50	11·59	10·50
Grains and Grain Offal	Maize	9·00	1·21	0·02	0·65
	Middlings	16·00	4·63	0·15	2·25
	Wheat	12·00	1·86	0·08	0·97
	Oats	12·00	3·71	0·16	0·99
Fodder	Alfalfa Hay	15·00	6·89	1·58	0·54
	Clover Hay	13·00	7·31	1·73	0·42
	Timothy Hay	8·50	3·47	0·27	0·28
	Oat Straw	2·50	4·40	0·36	0·18

The animal products included in the above table contain all the essential minerals in the proportions required for growth.

The milk of each species is exactly adjusted to the requirements of the young of that species. As these requirements vary according to the composition of the body and the rate of growth of different species the percentage composition of the mineral matter of the milk varies. Thus the rapidly growing young pig receives a milk with a higher percentage of lime and phosphorus than the more slowly growing calf. The percentage of the different minerals in the milk of any species is an excellent guide to the composition of the mineral matter that should be aimed at in making up a ration for the young animals.

Fish meal being made from bones and flesh contains all the mineral matter in the proportion required to form these. It will be seen that the ratio of lime to phosphorus in fish meal is not unlike that in sow's or cow's milk. The percentages, however, are so high that comparatively small amounts of this meal added to a ration yield a sufficient supply of these.

Other animal products such as blood meal are usually poor in mineral matter unless they contain ground bones.

The grains and grain offal are markedly deficient in lime and have a relative excess of phosphorus. A pig four months old if fed on a mixture of the grains and grain offal in the above table would require to eat 20 lbs. per day to get its daily requirement of one third of an ounce of lime (CaO), and in that amount it would have nearly four ounces of phosphorus (P_2O_5). It is impossible with a ration consisting only of grain to get the mineral matter balanced to suit the animal.

Fodders differ considerably in their mineral content. Thus clover and alfalfa are very rich in lime compared with timothy hay. In pasture, the minerals present vary with the nature of the soil, the flora and the season. In general, pasture contains more lime than phosphorus. In some cases, indeed, there is a deficiency of phosphorus leading to nutritional disorders, as occurs in the case of Lamziekte referred to below.

As the plant ripens, phosphorus tends to accumulate in the seed. As a general rule the green leaf is rich in calcium and the seed in phosphorus. Emphasis has been laid on this distribution of these two minerals by McCollum of America, who has shown that the whole plant, both leaf and seed, must be included in the ration if it is to be properly balanced as regards minerals.

In dealing with the mineral content of feeding stuffs, it must be kept in mind that the amount of any mineral that can be absorbed and utilised depends upon the amount and nature of the other constituents of the ration, and also upon the form in which the mineral itself is present. In some experiments carried out at the Rowett Research Institute, which will be dealt with in a later communication, the results showed that, though the necessary amount of either lime or phosphorus was present, it could not be fully utilised by the animal when there was a marked excess or deficiency of certain other minerals. Equally important are the organic constituents. The addition of cod-liver oil to a ration deficient in lime led to an immediate increase in the amount of both lime and phosphorus absorbed and retained. It is probable that the well-known beneficial effect of cod-liver oil on the growth and health of young animals is directly connected with its influence on the absorption and utilisation of these minerals.

The percentage utilisation of lime and phosphorus is greatest in the case of a young animal receiving its mother's milk. In the milk all the different minerals are present in the amount required, and consequently the ratio of the different minerals to each other and to protein are exactly adjusted to the needs of the growing animal. The utilisation is less when a young animal is fed on the milk of a different species, as when a sucking pig is fed on cow's milk, and it is still less in the case of other foods. In general, the better the ration is balanced with regard to all its constituents the more completely is each mineral utilised, and the better the result on the health and rate of growth of the animal.

Effects of Deficiency of Mineral Matter.—Since lime and phosphorus are required in considerable amounts as constructive material, it is not surprising that both are limiting factors for growth. If the building material is not present in sufficient amounts, increase in weight, due to formation of new tissue, slows down. The following experiment illustrates the influence of mineral matter on the rates of gain in growing pigs. Two groups of animals were given a ration consisting of grains and grain offal which contained 4·56 grams of phosphorus (P_2O_5), but only 0·47 grams of lime (CaO).

In the pen of one group a box was kept, which was filled with a mixture of salts, consisting chiefly of chalk, bone meal, rock salt and coal ashes. This mixture was eaten by the animals, and had to be renewed from time to time. No salt mixture was provided for the other group. Both groups were housed under conditions which gave no opportunity for the animals to supplement the mineral in the food from other sources. The average rates of gain are shown in the following table :—

	Initial Weight. Lbs.	Weight after 124 days. Lbs.	Gain. Lbs.
Ration only . .	32·1	101·4	69·3
Ration, plus salts .	31·5	164·3	132·8

In a case of deficiency of phosphorus the slowing down of the rate of growth is even more striking, but the deficiency is much less likely to occur in practice.

In addition to the diminution of growth, mineral deficiency early affects the health. The following examples of nutritional disorders arising from this cause show the great importance of what has been termed the "inorganic" constituents of the food.

From the results of recently published experiments, it appears that a lack of the proper amount and the proper composition of mineral matter in the food of the growing pig may lead to a very common form of disease, in which the animal ceases to thrive, develops a rough staring coat, gets "up in the back," and finally goes "off its legs." In severe cases deformities of the bones of the legs occur. This is very apt to occur on a ration of grains and grain offal with a great excess of phosphorus and a deficiency of lime, if the animal is confined and has no chance of supplementing the minerals in its food from a salt box or from rooting in the earth. The adjustment of the mineral matter of the food prevents the disease.

Pastures deficient in phosphorus fail to maintain a healthy and vigorous race of horses. An interesting case of this kind occurred at Behar, in India, where malnutrition of horses was shown to be associated with a pasture poor in phosphorus. On the other hand, a nutritional disease accompanied by pathological changes in the bones occurs in horses on a ration containing too much phosphorus and too little lime. Ingle, who has studied this disease in horses in South Africa, has urged the importance of considering the "amount and *composition*" of the ash of the food for maintaining the health of the animal.

Pica, a disease in which animals show a depraved appetite, eating manure and chewing various objects, seems to be associated with a deficiency of mineral matter in the food. This symptom has been observed in all experiments in this Institute when the animals were on a ration purposely devised to contain too little of either lime or phosphorus. Pigs drank the urine of their neighbours, and when liberated in the courtyard ate the fæces of the other farm animals. The fæces are comparatively rich in lime and phosphorus. In herbivorous animals these minerals are chiefly excreted in the fæces.

A very striking example of this symptom of malnutrition has been brought to light in the study of Lamziekte—a disease prevalent in certain districts of South Africa. As the result of research work, it has been proved that Lamziekte is contracted through the eating of putrid carcases and rotten bones, and that the cattle which show this depraved appetite are suffering from deficiency of phosphorus. When the food is arranged so that the mineral matter is supplied in proper amount and composition the desire to gnaw rotten bones disappears.

In this article the minerals discussed have been lime and phosphorus, the two which are required in largest quantities. There are altogether, however, ten or twelve minerals which are required to keep animals in health. In some cases disorders of nutrition may be caused by excess or deficiency of some of those which are required in smaller amounts. An interesting example of malnutrition caused by excess of one of these minerals has been studied by Zuntz, a German investigator, who has shown that disease may be caused by feeding certain hays with a great excess of potassium over sodium.

Practical Conclusions.—The importance of the protein content and of the energy yielding or "starch value" of foods has been sufficiently recognised. Indeed, the tendency has been to estimate the nutritive value of foods from these qualities alone, and to assume that the mineral matter stated as "total ash" in the tables of food values is likely to be sufficient. The experimental work referred to above shows that the amounts of lime and phosphorus are as important as the amount of protein or the energy value, and that the ratios of these minerals to each other and to protein are probably more important than the ratio of protein to energy value to which so much importance has been attached.

There is probably no subject in nutrition on which information is more needed than the mineral requirements of animals, and the best combination of foodstuffs to provide a ration with properly balanced minerals. Further knowledge would enable us to get more rapid gains in weight and a more economical use of feeding-stuffs, and would also probably throw light on many conditions of malnutrition whose causes are at present obscure.

The importance of minerals for raising crops is well recognised. It is very probable, however, that the view has been too limited. The soil and the added manures should be regarded not only in the light of the yield of crop or even of the number of food units of the yield, but also in the light of the mineral requirement of the animal and of pathological conditions produced in animals through improper mineral balance in foods derived from the crop. This is a field of investigation with great economic possibilities. For their success the investigations would require to be very comprehensive, including the practical and clinical experience of the farmer and practically every branch of the science of agriculture.

Even with our present limited knowledge it is possible to state some facts that are worth keeping in view in arranging rations :—

1. Failure to grow at the maximum rate and also certain diseases may be due to a deficiency of certain minerals in the food or a lack of the proper proportion of the minerals to each other.
2. Lime, one of the minerals which is required in large amounts, is markedly deficient in grains and grain offals.
3. Green foods, especially leguminous plants like clover, are rich in lime. These and foods derived from them, such as silage and clover hay correct the mineral deficiency of grains and meals.
4. The value of milk and milk residues such as whey solids, which contain most of the mineral matter of the milk, is largely due to the fact that they contain all the essential minerals in the amounts and proportions required by the growing animal and the well-recognised value of clover pastures, leguminous silage, fish meal and other foodstuffs rich in lime depends largely upon the fact that the mineral matter contained in them corrects the deficiencies of grain, grain offal and many other concentrates.

[*Note.*—The writers wish to acknowledge their indebtedness to George A. Bruce, Esq., of Inschfield, Insch. His wide practical experience was of assistance in connection with the experiments on which this article is based, and he allowed his valuable herd of large white pigs to be used to confirm the results obtained in experiments carried out at the Rowett Institute.]

THE EFFECT OF VARIATIONS IN PRICES UPON COSTS OF PRODUCTION AND FINANCIAL RESULTS.

JAMES WYLLIE, B.SC., N.D.A. (HONS.).

IT is obvious that a change in the selling price of any farm product or in the buying price of some commodity necessary in production must have an effect on the net financial result ; and it is important to be able to determine, for different systems of farming, what the effect of any such change may be. For example, to what extent does a variation of 10 per cent. in the cost of man labour (wages) affect the final result (net profit or loss) in the case of hill sheep farming as compared with milk production ; what effect has a 10 per cent. reduction in the cost of feeding farm horses upon the cost of horse labour per hour, and how does this affect the relative costs per acre of barley and turnips ; whether has a 5 per cent. increase in the cost of foods, manures and seeds, or a 20 per cent. increase in rent and rates the greater effect upon the net results ; how does a 10 per cent. decrease in the cost of manures compare with a similar decrease in the cost of feeding stuffs, and so on ?

The importance of this question lies principally in the fact that absolute increases or decreases, upon which attention is chiefly concentrated, may be highly misleading : an absolute increase of 50 per cent. in the cost of one element may be *relatively* less important than an absolute increase of only 5 per cent. in the cost of another element. Further, it is obvious that a variation in the price of a certain commodity will affect one class of farmers more than another, one district more than another, and so on.

Some interesting and, it is thought, useful information in this connection can be gleaned from the writer's reports to the Board of Agriculture for Scotland on the cost of milk production and on financial results and costs of production—mainly for the year ended Whitsunday 1921.

Milk Production.—Take first the case of milk. Table I. gives a summary of the average costs per gallon of each item, gross and bare farm costs per gallon (all in pence), total milk yield and average yield per cow-day on thirty-two farms scattered throughout Scotland (twenty-four in the west and south-west, and eight in the east and north-east) for the year ended 14th May 1921, together with an estimate of the probable costs for the year ended 13th May 1922.

From this table, it is clear that a 10 per cent. variation in the cost of man labour would affect the farm cost of milk by one-third of a penny, whereas a similar change in the cost of purchased foods would result in a difference of three-farthings per gallon, and in the cost of home-grown foods (crops and grass) of practically the same amount, or three-halfpence per gallon taking all foods into account. In other words, a decrease of 10 per cent. in the cost of foods would have about the same effect upon the final cost of milk as a 50 per cent. decrease in the cost of man labour.[1]

Again, a 10 per cent. increase in the yield of milk would cause a lowering of the milk cost by 1·68d. per gallon, or more than that caused by a 10 per cent. reduction in the cost of foods, while such a decrease in the costs of production accompanied by an increase in yield of 10 per cent. would result in a gross farm cost of 15·1d. per gallon—a saving of 3·35d. per gallon.

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[1] Each of these results is true, provided only (1) the year 1920-21 is taken as the standard, and (2) all other things are equal. In order to save needless repetition, these qualifications should be understood in all such comparisons.

In practice, however, there is no such uniform variation in the costs of the different factors, and in order to arrive at a fair estimate of the probable costs of milk in 1921-22 it is necessary to take each item separately, as shown in Table I. It must be clearly understood that the variations suggested are more to illustrate the principle of the method than to show the actual cost of milk in 1921-22.

TABLE I.

AVERAGE COSTS OF MILK PRODUCTION ON THIRTY-TWO SCOTTISH FARMS FOR THE YEAR 1920-21, TOGETHER WITH AN ESTIMATE OF THE PROBABLE COSTS FOR THE YEAR 1921-22.

	Actual Costs, etc., in 1920-21.	Estimated Percentage Decrease for 1921-22.	Estimated Costs, etc., in 1921-22.
	D.	Per cent.	D.
Man Labour—Production only	3·22	15	2·74
Foods—Purchased	7·21	27	5·26
Home-grown crops	5·16	18	4.23
Grazing	2·54	10	2·29
Milk fed to calves	·97	15	·82
Total cost of foods	15·88	21	12·60
General expenses	1·00	15	·85
Interest on capital	1·25	...	1·25
Management	·99	...	·99
Total costs	22·34	18	18·43
Deductions: Live stock account—Credit	2·08	15	1·77
Manurial value	1·81	15	1·54
Total deductions	3·89	15	3·31
Gross cost on farm	18·45	18	15·12
[1] *Bare cost on farm*	16·21	20	12·88
Total milk yield—gallons	643,421	...	643,421
Average yield per cow-day: Cows in milk—gals.	2·19	...	2·19
All cows—gals.	1·74	...	1·74

[1] *I.e.* Gross cost *less* interest on capital and management.

Man labour has been put at 15 per cent. less, but no strict accuracy is claimed for this figure. The reduction of 27 per cent. in the cost of purchased foods is based upon the probable cost in 1921-22 of the same kinds and quantities as were actually used on these farms in 1920-21. Thus, during the winter period of 1920-21, 204 tons of bean meal were used at a cost of £4088, or £20, 0s. 9d. per ton; 93 tons of linseed cake at a cost of £2017, or

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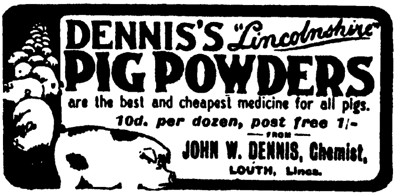

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£21, 13s. 9d. per ton; 69 tons of dried grains at a cost of £877, or £12, 14s. 2d. per ton, and so on. For the winter period of 1921-22, these three foods have been priced at £13, 15s., £16 and £8, 15s. per ton respectively. In this way it was found that the foods which cost £17,017 during the winter period of 1920-21 would have cost somewhere about £12,386 during the corresponding period in 1921-22—a decrease of 27 per cent.

Home grown crops have been dealt with in a similar way, except that average farm market prices are used instead of actual cost prices on the farm. Thus, in 1920-21, hay was charged at an average price of £4, 15s. 7d. per ton, oat straw at £3, 9s. 10d,. crushed oats at £12, 1s. 9d., turnips at 19s. 9d.,, swedes at £1, 8s. 1d., and so on. For 1921-22, the corresponding prices for these foods (in the same order) have been taken at £4, 10s., £2, £8, £1 and £1, 5s. respectively. The total charge for these foods during the winter period of 1920-21 was £14,152, and the estimated farm market value of the same quantities in 1921-22 was £11,543—a decrease of 18 per cent.

The cost of grazing has been put in at 10 per cent. and of milk fed to calves at 15 per cent. less; general expenses have been reduced 15 per cent. while interest and management charges have not been altered.

The credit in the live stock account has been decreased by 15 per cent., chiefly on account of the reduced prices for cast cows, and the credit for manurial value also by 15 per cent.

On the basis of these changes, the average gross farm cost per gallon in 1921-22 works out at 15·12d., and the bare farm cost at 12·88d., *assuming no change in the total yield of milk.*

The variation in the milk yield is extremely difficult to estimate. The summer of 1921 was abnormally dry, whereas the autumn and early winter were exceptionally favourable for grazing; during the summer more hand-feeding and during the autumn and early winter less hand-feeding than usual was necessary. On the whole, it is probably fair to reckon on a 5 per cent. decrease in the total milk yield during 1921-22, *i.e.* on the basis of the same consumption of purchased foods and home-grown crops. This variation would increase the final costs given above by about ·8d. per gallon.

Hence, after giving effect to the variation in each factor, the *final result* shows a decrease of about 14 per cent. in the gross farm cost of milk production in 1921-22 compared with 1920-21, or about 15 per cent. in the bare farm cost.

Horse Labour.—The average cost of keeping farm work horses on twenty-five farms scattered throughout Scotland for the season 1920 was found to be 33s. 2d. per horse per week, and the average cost per productive horse-hour was 1s. 3½d., this being the average rate at which horse labour was charged against 1920 crops. Of the total cost, 75 per cent. was for foods, 15 per cent. for depreciation and deaths, and 10 per cent. for other items—shoeing, harness upkeep, veterinary expenses, etc.

From these figures it appears that a 5 per cent. variation in the cost of feeding farm horses is relatively more important than a 35 per cent. variation in the cost of " other items " above mentioned.

For crops harvested in 1921, the cost of horse labour was considerably reduced on account of the fall in the farm market value of crops fed to horses, which cannot be put at less than 40 per cent. No reduction can be made for depreciation and deaths, but 10 per cent. may be taken off "other items." On this basis, the cost of horse labour of 1921 crops works out as follows :—

	Cost per Horse Week for 1920 Crops.	Estimated Decrease.	Estimated Cost for 1921 Crops.
	S. D.	Per cent.	S. D.
Foods	24 10	40	14 11
Depreciation and deaths ,	5 0	...	5 0
Other items . . .	3 4	10	3 0
Total . .	33 2	31	22 11
Cost per productive horse-hour	1/3½	31	10¾d.

Crops in 1921.—The crops of 1921 can be treated on the same lines as milk, and Table II. gives a summary of the average costs on a number of farms scattered throughout Scotland for oats and potatoes in 1920; also an estimate of the probable costs of these crops in 1921.

TABLE II.

AVERAGE COSTS AND ESTIMATED AVERAGE COSTS PER ACRE OF OATS AND POTATOES IN 1920 AND 1921 RESPECTIVELY.

	OATS.			POTATOES.		
	Average Costs per Acre for 1920 Crop.	Estimated Increase (+) or Decrease (−).	Estimated Costs per Acre for 1921 Crop.	Average Costs per Acre for 1920 Crop.	Estimated Increase (+) or Decrease (−).	Estimated Costs per Acre for 1921 Crop.
	£ s. d.	Per cent.	£ s. d.	£ s. d.	Per cent.	£ s. d
Man labour . .	3 0 9	(−) 15	2 11 8	10 6 9	(−) 15	8 15 9
Horse labour .	2 5 5	(−) 31	1 11 4	5 18 6	(−) 31	4 1 9
Total labour .	5 6 2	(−) 22	4 3 0	16 5 3	(−) 21	12 17 6
Seed . . .	2 1 5	(−) 40	1 4 9	9 11 3	(−) 50	4 15 8
Manures and cleaning costs . .	2 1 6	(+) 8	2 4 10	8 16 0	(+) 8	9 10 1
Rent and rates .	1 2 9	(+) 5	1 3 11	1 14 1	(+) 5	1 15 9
General expenses .	1 16 7	(−) 10	1 12 11	2 8 7	(−) 10	2 3 9
Total cost [1] .	12 8 5	(−) 16	10 9 5	38 15 2	(−) 19	31 2 9
Credit for straw or "brock" . .	2 3 4	(−) 30	1 10 4	1 0 8	(−) 20	0 16 6
Net cost of grain and of seed and ware	10 5 1	(−) 12	8 19 1	37 14 6	(−) 19	30 6 3

Note.—Averages for oats are from 1884 acres on thirty-two farms, and for potatoes from 148 acres on six farms.

[1] Does not include interest or management charges.

According to this table, a 10 per cent. variation in wages would cause a variation of 6s. 1d. per acre in the cost of oats and of 20s. 8d. in the cost of potatoes, while a similar variation in the rent and rates would affect the final cost by only 2s. 3d. and 3s. 5d. per acre respectively. Of the rent and rates only from 2s. to 4s. per acre represents local rates, and hence, although the absolute increase in rates may be very striking, such an increase may be relatively unimportant. In other words, a study of such results as are given above for 1920 crops brings home the need for attaching the proper weight to each separate cost factor.

If now we attempt to translate the 1920 crop costs into terms of 1921 crops, we must first of all assume similar conditions regarding weather, size of crops, etc. After full consideration and enquiry, the increases and decreases in the various cost-items have been arrived at as shown in the table; but it must again be emphasised that this table is intended to illustrate a principle rather than to attempt to show actual average costs for 1921 crops; further, the results will be more correct when applied to a number of farms than when applied to an individual farm.

It will be seen that although there are changes varying from a decrease of 31 per cent. in the cost of horse labour to an increase of 8 per cent. in the cost of manures, the final cost per acre of oats works out at £10, 9s. 5d. as against £12, 8s. 5d. in 1920—a decrease of 16 per cent. After allowing for the reduced value of the straw, the net cost per acre of 1921 grain is only 12 per cent less than in 1920. Similarly, the cost per acre of potatoes (after deducting from labour a proportion of the cleaning costs) averages £31, 2s. 6d. in 1921, compared with £38, 15s. 2d. in 1920—a reduction of 19 per cent.

However, before coming to a final conclusion regarding the relative costs of 1920 and 1921 crops we must also take into account the variations in the weather and their effects upon (1) the cost of man and horse labour, and (2) the yields of the various crops, the latter again reacting upon labour costs and also upon the costs of threshing, dressing, marketing, etc. It is here that one is forced to recognise the necessity of having cost data for a period of years, and until such are available it will be impossible to say what are the final effects of such variations upon the costs per quarter, per ton, etc. For example, the weather may cause an increase in the labour costs at seed time, harvest, etc., even though the yields may be the same, whereas it may also cause a decrease in such costs on account of its effect upon the yields. Further, the larger the crop the greater will be the expenses of harvesting, threshing, dressing and marketing.

The average yield of grain in 1920 on the farms included in Table II. was 40·8 bushels per acre, and of ware and seed potatoes 8·45 tons, compared with the official averages for Scotland of 40·0 bushels and 7·6 tons respectively. In 1921, the official averages for Scotland were 37·9 bushels of oats and 6·8 tons of potatoes per acre, *i.e.*, decreases of 5¼ per cent. and 10½ per cent.

respectively. If we assume the same average decreases on the farms in Table II. we arrive at average yields of 38·6 bushels of grain and 7·56 tons of potatoes per acre. We now have the following final results:—

	Oats.			Potatoes.		
	1920.	Decrease.	1921.	1920.	Decrease.	1921.
	£ s. d.	Per cent.	£ s. d.	£ s. d.	Per cent.	£ s. d.
Net cost per acre .	12 8 5	16	10 9 5	38 15 2	19	31 2 9
Credit for straw and for "brock" .	2 3 4	30	1 10 4	1 0 8	20	0 16 6
Net cost per acre of grain and of ware and seed . .	10 5 1	12	8 19 1	37 14 6	19	30 6 3
	Bush.		Bush.	Tons.		Tons.
Average yield per acre . . .	40·8	5¼	38·6	8·45	10½	7·56
Net cost per quarter of grain . .	40/2	8	37/1	...	...	...
Net cost per ton of ware and seed .	...	...	...	89/3	10	80/2

It would appear therefore that although the total net cost per acre of oats in 1921 was reduced by 16 per cent the net cost per quarter of grain was reduced by only 8 per cent; similarly, the net cost per ton of ware and seed potatoes fell by only 10 per cent. compared with a 19 per cent. reduction in the total net cost per acre.

This comparison, however, is still incomplete, as it has not taken into account the fact that the weather, both at seed time and at harvest, was more favourable in 1921 than in 1920, while no allowance has been made for the slight reduction in costs which follows upon the reduced yields. But it is probable that the tendency is to over-estimate the importance of these factors in relation to the final costs per quarter or per ton since more horse labour does not necessarily mean higher horse labour costs per acre or per quarter, etc.: it may merely mean increased economic efficiency on account of fuller employment; while the regular staff of workers must be maintained in any case and any variation will be chiefly in the cost of casual labour at harvest, threshing, etc.

As already indicated, no figures can even be suggested under these heads since there is positively no basis to work upon.

Incidentally, attention may be called to the fact that the relative importance of the various cost factors does not remain the same from year to year. Thus, in 1920, 16·7 per cent. of the total net cost per acre of oats consisted of seed and 9·2 per cent. of rent and rates, while in 1921 the corresponding percentages were 11·8 and 11·4 respectively. This is a fact of considerable practical importance.

Financial Results.—It is now desirable to take a more general view of the effects of variations in prices upon the net results of farming operations, and for this purpose the financial accounts of sixty-one farms scattered throughout Scotland will be taken as the basis. Of these, twenty-nine are ordinary lowland farms—dairying, mixed, etc., for which the financial year ended on or about Martinmas 1920, while twenty-seven are lowland and five hill sheep farms for which the year ended at Whitsunday 1921.

Table III. gives a summary of the average expenditure and income for each of these three groups while Table IV. gives a similar summary for each of the four systems of farming comprised in the Whitsunday group. Each item of expenditure and income is given (1) per acre and (2) as a percentage of the total expenditure and income respectively.

It will be noticed that a decrease in the valuations at the end of the year has been reckoned as expenditure and an increase as income.[1] "Man labour" includes not only wages and insurance paid but also the value of perquisites and allowances and of unpaid household labour. The farm account has been credited with the value of all produce used in the farmhouse, together with a share of the cost of upkeep of the driving pony or motor car, of coals and lighting oil, etc. No charge has been made for interest on the farmer's capital nor for the value of manual work or of management done by him. For a fuller account of these various items reference should be made to the report already cited.

In the interpretation and application of the results shown in these tables, chief attention should be paid to the per-acre figures, but the percentage figures are useful in showing at a glance the relative importance of the various factors.

A comparison of the results for the Martinmas and Whitsunday groups (Table III.) indicates several radical differences, not only in the total expenditure and income, but also in the composition of that expenditure and income. These differences are due partly to the fact that the Whitsunday farms experienced the fall in prices which set in, especially in crops and in milk, between Martinmas 1920 and Whitsunday 1921, and partly to the fact that the "average" system of farming in the two groups was not quite the same, *e.g.*, more wheat and potatoes were grown on the Martinmas than on the Whitsunday farms and there was less milk selling. Table IV. again, shows that similar radical differences exist in the results from the different systems of farming included in the Whitsunday group. A more detailed analysis of the various items of expenditure and income would reveal that in the case of crop sales, for example, some farms sell nothing but oats, others sell oats, wheat, barley, hay and potatoes, and so on; that sales of live stock consist chiefly of sheep on some farms, of pigs on others or of both cattle and sheep; and so on. But probably the general principles with which we are mainly concerned can be shown more clearly by the broad analysis which has been given in these tables.

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[1] This has been done for simplicity. Strictly, depreciation on equipment and on work horses should have been separately charged in every case and the difference between the valuations then entered. The net result is the same either way.

Now consider first the relative effects of variations in prices upon the different items of expenditure and income *in any given* *system of farming.* If we look upon the twenty-seven Whitsunday farms as forming one large mixed lowland farm of 7866 acres, it will be seen that the most important item on the expense side is live stock purchases with a total of 38·8 per cent. (chiefly cattle 25·4 and sheep 11·2 per cent.). Materials (consisting of foods 9·7, manures 5·9, seeds 2·7 and general stores 1·3 per cent.) and manual labour (of which four-fifths is cash wages) come next

TABLE III.

SUMMARY OF EPPENDITURE AND INCOME FOR FIFTY-SIX LOWLAND AND FIVE HILL SHEEP FARMS.

EXPENDITURE.						
CLASS . . .	Lowland.				Hill Sheep.	
SUB-CLASS . .	Martinmas.		Whitsunday.		Whitsunday.	
NUMBER OF FARMS	29		27		5	
AVERAGE ACREAGE.	291		298		4576	
	Per acre.	Per cent.	Per acre.	Per cent.	Totals.	Per cent.
	£ s. d.		£ s. d.		£	
Live stock purchases .	5 6 5	28·3	6 3 10	38·8	3,398	21·2
Equipment ,, .	1 4 1	6·4	0 15 5	4·8	1,194	7·5
Material ,, .	5 12 3	30·0	3 2 6	19·6	2,452	15·3
Manual labour . .	3 15 3	20·0	3 4 2	20·1	4,942	30·9
Rent and rates . .	1 9 11	8·0	1 3 2	7·3	2,233	14·0
Other expenditure .	1 7 3	7.3	1 9 7	9·3	1,793	11·1
Decrease in valuations .	...	...	0 0 6	·1	...	...
Total expenditure .	18 15 2	100·0	15 19 2	100·0	16,012	100 0
Net profit . .	3 16 10	...	1 6 0	...	5,173	...
Total . .	22 12 0	...	17 5 2	...	21,185	...
INCOME.						
Live stock sales . .	10 8 9	46·2	10 16 2	62·6	16,995	80·2
Live stock product sales	2 9 1	10·9	2 10 6	14·6	439	2·1
Crop sales . . .	7 13 2	33·9	2 17 7	16·7	257	1·2
Other income . .	0 2 1	·4	0 5 5	1·6	358	1·7
Perquisites to workers .	0 7 4	1·6	0 6 9	2.0	619	2·9
Transfers to personal account . . .	0 9 2	2·0	0 8 9	2·5	617	2·9
Increase in valuations .	1 2 5	5·0	...	...	1,900	9·0
Total income .	22 12 0	100·0	17 5 2	100·0	21,185	100·0

with 20 per cent. each; rent and rates form only 7·3 per cent. of the total, purchased equipment 4·8 per cent. and sundries 9·3 per cent. Hence, a 10 per cent. variation in the buying prices of cattle and sheep, a 20 per cent. variation in the cost of foods, manures and seeds or in the cost of manual labour and a 50 per cent. variation in the rent and rates would have approximately the same effect upon the total expenditure and therefore upon the net results.[1]

TABLE IV.

SUMMARY OF EXPENDITURE AND INCOME ON FARMS UNDER DIFFERENT SYSTEMS OF FARMING FOR YEAR ENDED WHITSUNDAY 1921.

				EXPENDITURE.				
SYSTEM OF FARMING	Dairying—Milk-Selling.		Mixed—Dairying, etc.		Mixed—Non-Dairying.		Stock—Rearing.	
NUMBER OF FARMS .	7		3		15		2	
AVERAGE ACREAGE .	198		285		314		462	
	Per acre.	Per cent.	Per acre.	Per cent.	Per acre.	Per cent.	Per acre.	Per cent.
	£ s. d.		£ s. d.		£ s. d.		£ s. d.	
Live stock purchases .	1 6 4	9·5	5 2 6	28·5	8 9 11	47·3	2 15 8	31·4
Equipment ,, .	0 16 9	6·1	0 10 4	2·9	0 15 2	4·2	0 18 10	10·6
Material ,, :	4 12 4	33·4	3 16 2	21·2	2 17 1	15·9	1 13 2	18·7
Manual labour . .	3 7 8	24·5	4 17 3	27·0	3 1 11	17·2	1 19 6	22·3
Rent and rates . .	1 4 4	8·8	1 13 0	9·2	1 2 9	6·4	0 13 9	7·8
Other expenditure .	1 9 9	10·7	1 7 5	7·6	1 12 6	9·0	0 16 5	9·2
Decrease in valuations.	0 19 3	7·0	0 13 2	3·6	..	...	...	..
Total expenditure .	13 16 5	100·0	17 19 10	100·0	17 19 4	100·0	8 17 4	100·0
Net profit . .	1 19 2	..	...	...	1 4 11	...	2 8 1	...
Total . .	15 15 7	...	17 19 10	...	19 4 3	...	11 5 5	...
				INCOME.				
Live stock sales . .	3 11 4	22·6	6 15 1	38·8	14 5 9	74·4	7 14 0	68·4
Live stock product sales . . .	9 14 6	61·6	4 16 4	27·7	0 5 5	1·4	1 2 1	9·8
Crop sales . . :	1 0 6	6·5	4 14 7	27·1	3 11 8	18·6	0 6 8	3·0
Other income . .	0 13 8	4·4	0 4 11	1·4	0 3 2	·8	0 5 5	2·4
Perquisites to workers.	0 2 1	·6	0 13 7	4·0	0 6 10	1·8	0 6 9	3·0
Transfers to personal account . .	0 13 6	4·3	0 3 7	1·0	0 7 11	2·1	0 10 9	4·8
Increase in valuations .	...	...	...	...	0 3 6	·9	0 19 9	8·6
Total income .	15 15 7	100·0	17 8 1	100·0	19 4 3	100·0	11 5 5	100·0
Net loss . .	...	...	0 11 9	...	...	...	...	..
Total . .	15 15 7	..	17 19 10	...	19 4 3	..	11 5 5	...

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[1] See foot note on page 251.

On the income side of the account, the preponderance of live stock sales is very marked. Of the total income, no less than 62·6 per cent. (including cattle 40·1 and sheep 19·2 per cent.) was from this source while a further 14·6 per cent. (including 12·5 per cent. from milk and ·9 per cent. from wool) was from sales of live stock products, compared with only 16·7 per cent. from crop sales (including barley 4·8, oats 4·9, hay 2·4 and potatoes 2·1 per cent.). In other words a 10 per cent. decrease in the selling prices of cattle and sheep would have practically the same effect upon the net results as a 40 per cent. decrease in the prices of crops or of live stock products, while a reduction of only 1 per cent. in the selling prices of cattle and sheep would be the equivalent of a 40 per cent. reduction in the price of wool and so on.

Similar calculations can be made for any one of the systems of farming shown in Table IV. and for the hill sheep farms in Table III.; also, of course, for any particular farm. By doing so the individual farmer can guard against being "penny wise and pound foolish."

Turning now to the *different systems of farming* we are able to compare the four systems given in Table IV. and the hill sheep farming in Table III. First, it will be noticed that whereas the cost of man labour varies from 17·2 per cent. (mixed non-dairying) to 30·9 per cent. (hill sheep) and of rent and rates from 6·4 per cent. (mixed non-dairying) to 14 per cent. (hill sheep) of the total expenditure, the percentage of live stock purchases varies from 9·5 (milk-selling) to 47·3 (mixed non-dairying) and of materials purchased from 15·3 (hill sheep) to 33·4 (milk-selling). Hence—other things equal—a 20 per cent. reduction in the cost of man labour would result in a saving of 12s. 7d. per acre on the mixed non-dairying farms, and of 19s. 5d. per acre on the mixed dairying farms; while a similar reduction in the cost of materials would yield a saving of £185 per farm in the milk selling group compared with £182 per farm in the mixed non-dairying group; and a reduction of 10 per cent. in the buying prices of cattle and sheep would be five times as important to the mixed non-dairying farmer as to the milk selling farmer, and so on.

Similar differences are found on the income side. Thus, the income from live stock sales constitutes from 22·6 (milk selling) to 80·2 (hill sheep) per cent. of the total, while the corresponding figures for live stock product and crop sales are 1·4 to 61·6 and 1·2 to 27·1 per cent. respectively. It is obvious, therefore, that a 10 per cent. reduction in the selling prices of cattle and sheep is much more important to the mixed non-dairying or hill sheep farmer than to the milk-selling farmer, while the stock-rearing and hill sheep farmers are practically indifferent to variations in the selling prices of crops (except in so far as they may be compelled to become buyers of these crops).

Such facts as the above emphasise the importance of judging things relatively rather than absolutely. For example, the fact that crop and fat stock prices may be low absolutely is not necessarily a reason for changing the system of farming, but if it can be shown that these prices are low relative to the prices for milk and cheese then there is good reason to contemplate a change. Further, it is clear that one important factor in the farm economy is the possibility of making changes in the system of farming. In this respect, hill sheep farming may be said to be stable whereas mixed dairying, for example, is elastic, and the farmer may develop whichever branch of the farm is proved to be paying best. It is in this connection that the importance of the situation factor (with reference to markets for crops and fat stock) is realised by the practical farmer.

In the third place, a comparison of the results for the Martinmas and Whitsunday groups (Table III.) indicates that the percentage of each item will vary from year to year on account of the irregular variations in prices and costs. It cannot be said, for example, that rent and rates form a fixed percentage of the total expenditure, for if rent and rates remain about their present level, while other costs continue to fall, the relative importance of this factor will gradually increase. In the same way, unless the fall in wages continues at something like the same rate as the fall in the buying prices of live stock and material then the cost of man labour will exceed the 20 per cent. here shown, *i.e.* it will become of greater weight upon the expenditure side of the scales. This matter can be easily tested by taking the results for any one system, inserting estimated increases and decreases in each item for the year ending Whitsunday 1922, and then recalculating the per-acre figures and also the percentage of each item; but the general principle is so clear that further exemplification is unnecessary.

Lastly, it may be mentioned that the relation between the expenditure on any single item and the total income per acre is also a matter deserving careful consideration, although beyond the scope of the present discussion. But reference to Tables III. and IV. will show at once the extent to which a 20 per cent. reduction in the selling prices of crops would be balanced by a similar reduction in the buying prices of foods, manures and seeds, or in the cost of man labour, and so on.

This article is not intended to be either exhaustive or conclusive. Until information, similar to that contained in the reports referred to, is available from a much larger number of farms and for a period of years, it will be impossible to do more than merely suggest the lines upon which the interpretation and application of the results would proceed. The main purpose has been to emphasise (1) that a broad view of price variations must be taken before arriving at any conclusions regarding their effects upon costs of production and financial results, and (2) that unless the relative importance of the various factors can be properly gauged the conclusions formed are likely to be erroneous.

THE BIOLOGIST ON THE FARM.—No. VII.

PROFESSOR J. ARTHUR THOMSON, M.A. LL.D.

Science and the Farmer.—We must be allowed to welcome the extraordinarily interesting and valuable record which Mr V. E. Wilkins has prepared for the Ministry of Agriculture and Fisheries (*Agricultural Research and the Farmer*, 1922, 2s. 6d.).[1] We have seldom read a book that fascinated us more, for it is an illuminating commentary on our favourite text, "Science is for Life." It shows how rapidly new knowledge of an applicable kind is growing, in regard to the soil and its crops, animal husbandry and breeding, animal diseases and their remedies. There is fine workmanship in this record of recent achievements in agricultural science in the broad sense, and we welcome a breeze which tells us that the days of folded hands and fatalism are over. The old farmers had an incalculably valuable lore, but much of it was non-transmissible. Let us keep all that can be handed on with a clear scientific conscience, but let us also welcome the new science which promises not only to illumine, but to *pay*.

Hookworms in the Soil.—Man has suffered much from microscopic animals, such as those which cause malaria, sleeping sickness and syphilis. He has also suffered much from minute animals which introduce bacteria into his body, such as the rat flea which introduced the bacillus of bubonic plague, the louse which inoculates man with typhus fever, the mosquitoes which are the vehicles of yellow fever. But perhaps it may be said that man has suffered more from hookworms than from any other animal. For hookworms are responsible for almost incalculable numbers of patients in warm countries who suffer from weakness, anæmia, depression and despair. There are two important hookworms, *Ancylostoma duodenale* of the old world, and *Necator americanus* of the new. They are threadworms or nematodes, about half an inch long in the female, and a third of an inch long in the male. They live chiefly in the wall of the intestine, and they sap man's strength. The eggs are liberated in the intestine, but do not develop there because of the lack of oxygen. They pass on to the earth in conditions of primitive sanitation, and there they hatch. After the second moult the minute thread-like larvæ are infective, and they enter man by boring through the skin, *e.g.* of the bare feet; and it is easy to understand why children are peculiarly liable to infection. In some cases the larvæ creep up on to plants and enter man along with vegetable food. The Rockfeller Institute has done a great work throughout the warmer parts of the earth by insisting on simple methods of cleanliness which prevent the soil round the village or township becoming abundantly contaminated with hookworm larvæ. It has recently been proved by W. W. Cort and D. L. Augustine, of Johns Hopkins University,

[1] This booklet is noticed briefly on page 319.

that the larvæ do not migrate far in the soil, so that soil-infestation is practically limited to the place of development. Moreover, the life of the larvæ in the soil has a short duration. In less than six weeks after the elimination of soil pollution from a cane-field, the hookworm larvæ in the soil had almost died out.

Nature's Sifting and Man's.—In nature's sifting there is a consistent handicapping and eventual elimination of creatures which have varied in the wrong direction, and are relatively less fit than their neighbours to particular conditions of life. Natural selection does not necessarily work for the strongest or quickest, the most fertile or the most brainy—it works towards what is relatively fittest to given conditions. The tapeworm is the outcome of selection as well as the golden eagle, and lice as well as lions. But, however nature's sifting works, it can never select what is disadvantageous to the type. That would be a contradiction in terms. Those variants survive which are fittest to survive. But it is otherwise in man's sifting, for he may set his mind on some character that is not desirable from the animal's point of view. He may breed for what is fatal, or, as they say nowadays, lethal. Thus Messrs L. J. Cole and J. G. Halpin report a case of years of selection of Rhode Island red fowls, where the premium was put on the colour of the plumage, which is a non-vital character. The artificial selection—artificial in two senses—resulted in a rapid deterioration of the stock, which ran out completely in four years. Egg-production was affected to some extent, but the deterioration was particularly noticeable in vitality, as measured by the hatchability of the eggs. This is very instructive. Mistaken selection led to a full stop. On the other hand, a second set of experiments, in which the selection was based on good hatchability and vigorous chickens, resulted in raising the general vitality of the stock.

Effect of Alcohol on Animals.—A good many experiments have been made as to the effect of alcohol on animals, but the results are somewhat discrepant. Rats and guinea pigs seem to suffer when treated, and the offspring likewise. It looks as if the unoxidised alcohol got at the reproductive cells, and poisoned them or enfeebled them. On the other hand, the treatment of poultry and some other organisms was not followed by deleterious results. In some of the experiments the alcohol was supplied with the food, but as that disturbed the digestion and complicated the issue, the method pursued in many cases was that of subjecting the creatures for a certain length of time per day to vapours of alcohol. Some recent experiments by E. Carleton MacDowell, of the Cold Spring Harbour Station for Experimental Evolution, are of considerable interest. The animals were white rats, the *corpora vilia* of so many experiments, and they were treated with alcohol fumes. A careful examination was made of those treated, of their untreated children, of their treated children, and of their untreated children's untreated children. Judged by their behaviour in a circular maze and by the size of their litters, all four groups showed a small amount of inferiority as compared with their respective controls.

The treated rats grew more slowly than their controls; their treated children about equalled their controls in growth and weight; their untreated children were heavier than their controls; and their untreated grandchildren showed a less positive tendency to surpass their controls. On the whole, one would not base an argument for prohibition on *these* experiments.

Inheritance of Resistance to Tuberculosis in Guinea Pigs.—The experimental student of heredity must work with cheap and rapidly multiplying material. Only after he has made sure of his conclusions on small creatures is it practicable to pass to animals like horses and cattle. But some of the experiments that are going on at a lower level are full of interest and promise. Take, for instance, the work of Sewall Wright and Paul A. Lewis, of the American Bureau of Animal Industry, on the inheritance of resistance to tuberculosis in guinea pigs. This has been tested in over 1100 guinea pigs belonging to five closely inbred families. The resistance is markedly heritable, and the progeny of crosses are in general at least equal to the better of the two parental families. For resistance is dominant over susceptibility to tuberculosis. There is equal transmission by sire and by dam, and to the two sexes of the offspring.

Inbreeding in Horses.—Almost all the recent work points to the conclusion that inbreeding is not in itself a bad thing, though it may serve to discover disadvantageous recessive characters which are kept latent in ordinary crossing. Friedrich Huff has recently investigated the history of *all* the members of the Waldfried stud of blood horses, and comes to the conclusion that inbreeding had no influence—for good or ill—on the speed or on the breeding qualities, except in some cases of very close breeding in and in where traces of deterioration were noticed. The analysis must go a step further, however, to show whether the outcrop of something disadvantageous is due to the inbreeding as such, or is simply that recessive taints found an opportunity to assert themselves.

The Web of Life Again.—The increase of zoological knowledge is always adding to the list of linkages binding one life to another. Here is one of the latest. All the different kinds of cockroach that have been carefully examined have particular species of bacteria living in their fatty bodies. They do no harm; in fact they seem to be partners (symbions) not parasites. Now it has been shown that the infection always begins in the egg. The partner bacteria are handed on from mother to offspring *in ovo*,—almost as if they were part of the inheritance. They enter the egg from both poles, and in the course of development they reach their appropriate destination in the fatty bodies. The work of Blochmann and Buchner has been recently confirmed by Helene Fraenkel (*Zeitschrift wiss. Zoologie*, 1922, cxix, pp. 53–66, 2 pls.).

The Stability of Nature.—Sometimes our strong impression is of the changefulness of living creatures. We visit an exhibition of pigeons and are amazed afresh that all these fantails, tumblers, pouters, homers, owls, and so on are scions of the Rock Dove species. We visit a rabbit show and are amazed afresh that all these angoras, lop-ears, and silkies, all these giant Flemish, dwarf Dutch, and big Belgian Hares, are scions of the wild rabbit stock. And all this variety of coloration—white, black, blue, black-and tan, and so on to tortoise shell—is potentially in the fur of the wild rabbit. But at another time we look at some creature like the lamp-shell (Lingula), which, as far as we can judge from the fossils, seems to have remained the same for many millions of years. Some animals like the fruit-fly, Drosophila, seem to be in a state of flux; others are just as characteristically stable. In many a farm-pool, there is a common "wheel-animalcule" or rotifer,—a multicellular animal with a very small pinhead body. Ten years ago, a zoologist counted the number of cells, or unit corpuscles of living matter, in this tiny creature, and found 959. He counted another and another, and each had the same number. Dr Shull has counted parts of 245 and found only 4 per cent. off the normal number; and Van Cleave has counted parts of 770 and found only three off the normal number. What constancy!

The Quest of Food.—We have often tried to discover how many different solutions have been offered of the bread-and-butter problem. Here is our latest attempt. (1) An animal may devour a plant, as the cow the grass. (2) An animal may eat what a plant has made without harming the plant, as a bee the nectar. (3) A green animal may feed like a plant, utilising the suns rays in photosynthesis; and it may be (*a*) green in its own right, like the green bell-animalcule, or (*b*) green, because of partner algaë, like the green freshwater sponge. (4) An animal may feed on another living animal, as a tiger on a antelope. (5) An animal may feed on dead flesh, like a carrion beetle. (6) An animal may live on rotten organic matter, prepared for it by bacteria, as is the case with many threadworms or nematodes. (7) An animal may feed on organic debris, or crumbs, as the earthworms on parts of plants lying on the ground. (8) An animal may depend on microscopic animals and plants in the surrounding water, like so many plankton-eating creatures of the open sea. (9) An animal may thrive through its partnership with another animal, whether an internal symbiosis (as in 3, *b.*), or an external partnership like that between certain hermit-crabs and certain sea-anemones. (10) An animal may be an external parasite, cleaning up the surface of its host's skin, as in the case of lice and some mites. (11) An animal may be an internal parasite, living (*a*) on the digested food in the alimentary canal of its host, *e.g.*, tapeworm; or living (*b*) on the actual tissue of its host, *e.g.*, liver-fluke on the blood of the sheep's liver. (12) An animal may be a predatory animal from within—surely not to be called a parasite—like the ichneumon grubs devouring the caterpillar.

The Biology of Brer Rabbit.—As we were walking on the links to-day we almost stepped on a young rabbit, which jumped into the air and with admirable skill or good luck swung itself into a hole in the bank. It pulled the trigger of our biological mood, raising many questions. The rabbit is no native of Scotland and probably came over to England with the Conqueror; it shows a remarkable adaptability to diverse climates and it thrives in Ireland. It is not a clever creature, but it out-wits the Australian Government. It has many enemies—fox and stoat, buzzard and owl—but it holds its own. This is partly because it has conquered the underworld and become to a great extent crepuscular. To be prolific is a virtue of a low order, but it spells a certain vigour of constitution, and the rabbit is hard to beat, with its litter of three to eight, perhaps four to eight times in a year. And the young are reproductive when about six months old. There is a pretty touch in the bed of fur which the doe makes for the young. One remembers Mr Rodier's plan of killing the does only in Australia, for then the bucks become predominant and kill the young ones. They also work the does to death. This has succeeded as a local method, but the only final cure for Australia is the spread of farming—which may seem like a contradiction in terms since the rabbits have turned vast areas of fertile ground into desert. There are some biologically interesting peculiarities in the life of rabbits—such as the danger signal made by thumping the hind legs, the use of the white tail as a signal to the inexperienced in the twilight, and the fear paralysis which sets in when the stoat is too near. We have used the title Brer Rabbit, but we do not suppose for a moment that this famous character was our rabbit.

THE MANAGEMENT OF HILL GRAZINGS.

DR R. SHIRRA GIBB.

THERE is so much pasture land in this country, of which only a comparatively small portion can be termed very good, that the study of the various methods in use for its improvement becomes one of very considerable interest, and of great economic value.

Since the war, the undoubted tendency in this country—much more than in other countries—has been to revert to grazing and meadows, and, while in many cases it may be a mistake from more than one point of view, yet it is not so unfortunate a process in every case as it might appear at first sight. For one thing, it affords—should ploughing be again called for, from whatever cause—an amount of "rested" land to fall back on, capable of producing crops somewhat above the normal.

When land is laid down to grass the whole attention is as a rule centred on the stock being grazed on it, little or no thought is given to the grasses—whether they are good growers, whether they are coarse or fine, whether they are digestible or not, whether there is much or little clover, etc.

There are very considerable areas of land, annually let as grass parks, all over the country; many of these are "policy" fields in connection with the proprietors' residences, and include some of the best agricultural land, and yet, seldom does either the proprietor or the factor ever think of doing anything for them. The grazings are let, year after year, by auction to the highest bidder. These fields are, in no sense, farmed; the *lessor* knows nothing about them, he leaves them alone and takes what rent he can get with seldom any thought of manuring, or of liming, or any other means of improvement. All that is done is to see that the fences are in good order.

Again what interest has the *lessee?* He takes the grazing and puts in any stock for which he may not have accommodation elsewhere, or he may have to buy stock for it—in the latter case his action will depend mainly on the state of the markets, with the result that the pasture may be very rough when it should be well eaten, and very bare when it should be allowed to develop. That pastures let from year to year do not deteriorate much more than they do, under this treatment or want of treatment, is mostly, as I said, because the land is naturally good, but often because they are grazed by a mixed stock, some sheep and some cattle. But all grazing land is not naturally good, and it certainly is not always grazed by a mixed stock. It is on this point that I would like to give graziers, proprietors, and others interested the benefit of a protracted experience.

Back in the eighties and nineties of last century, when my great friend, Dr Andrew Aitken, was chemist to the Highland and Agricultural Society, there was scarcely a field on this large farm which had not been the subject of some experiment or other under his direction, and many of these were on the broken-up and improved moorlands. More than once we found out points of interest, which others have since elaborated and claimed as original discoveries. It is not of these, however, that I want to speak, nor of the experiments in detail, but to point out the advantages to be derived from some of the more general conclusions at which we arrived.

We were not long in deciding, that, on grass land in a sheep breeding country, phosphates were the only essential ingredient in a manure; and that basic slag was specially good in this way, being better than superphosphates, steamed bone flour, or the various forms of ground rock phosphates; that lime was useful, but the large quantities usually applied were far too costly; nitrogen was almost always contra-indicated, and eventually made the pasture coarse and rough, and therefore was harmful; farmyard manuring and boxfeeding on the ground were also generally in the same category, and eventually produced a pasture forced and rough from excess of nitrogen, and, later on, an indigestible and non-assimilable turf, with only a few weak plants of wild-white clover.

I believe there are some parts of Scotland where potash does some good, but Lauderdale is not one of these parts, as, after some years of experimenting by most of the farmers in the valley, we found that in hardly any case did it pay for its application, and in not a few it did positive harm (see *Highland Society's Transactions*).

The valley is mostly on old red sandstone but thickly overlaid with boulder clay. I had occasion to be in the South of England lately on a farm overlying chalk, which was quite close to the surface, and I was interested to learn that there excess of potash is required to produce the maximum results. I do not feel inclined therefore to be dogmatic regarding the use of potash as a manure, but would strongly recommend the farmer to experiment in a small way first, before going extensively into its use either on arable land or on pasture.

Other substances were tried from time to time, as they came to the knowledge of the chemist. Among these were ground felspar rock from Norway, two or three forms of iron salts, various lime and magnesia compounds, lime residues and dung substitutes like shoddy: these were rejected, having produced either an unprofitable return or no return at all.

Trials of various other kinds took a lot of work, such as, the place for dung in a five course rotation; how thick to leave thinned turnips (bringing out the practical result that the weight of total crop was practically the same however they were thinned, or even not thinned at all); how to increase the percentage of sugar in turnips, etc. But these, though profoundly interesting in themselves are outside our present subject.

Slag—and the higher the grade the better—was what pasture wanted, and, as far as my own farm was concerned, this was the only manure that the pastures required. Except on the score of initial cost, you cannot, acting in reason, overdo its application, but, if applied on the surface, about 10 cwts. of 30 per cent. slag should, in two years, make a great difference to a pasture in which almost any wild-white clover plants are to be seen. There are two conditions under which this might not happen.

When the pasture is a mass of moorbent with its matted roots the slag will take at least the two years to get down to the soil, and the clover may take other two years to get the better of the moorbent. But it will do so, though it may take another 10 cwts. to be thoroughly effective. How it works is, that as the little clover plants are nourished, they push up to the surface with bigger, greener blades; the creeping stems work away under the surface, and send down their little rootlets, and send up their leaf stems, so that, whereas each little, puny plant had, formerly, only one or two leaves appearing above ground, each has now many leaves showing among the moorbent; the stock find these, and, in eating the clover have to take some of the moorbent which they would hardly touch before, so, as the clover grows the bent gets less, until the pasture becomes one with 40 per cent. – 50 per cent. white clover.

Having got the pasture fairly good you want to keep and develop it. It needs as much attention as an average arable field does. A gentleman who paid great attention to his pastures in the Borders was Mr Robert Elliot, of Clifton Park. His object was not to make a permanent pasture, but to sow and develop his temporary pastures for a certain number of years, so as to get good

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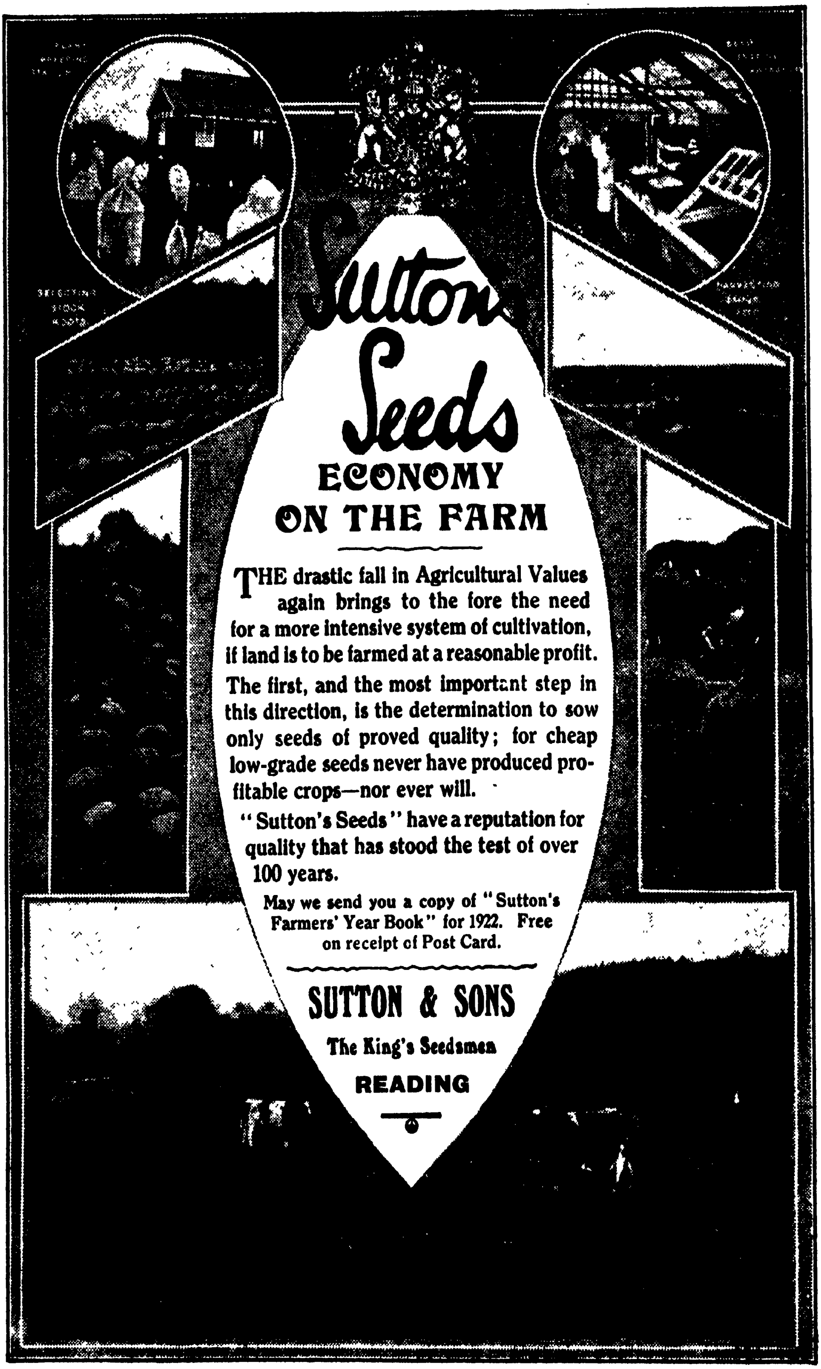

Sutton's Seeds

ECONOMY ON THE FARM

THE drastic fall in Agricultural Values again brings to the fore the need for a more intensive system of cultivation, if land is to be farmed at a reasonable profit. The first, and the most important step in this direction, is the determination to sow only seeds of proved quality; for cheap low-grade seeds never have produced profitable crops—nor ever will.

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crops of hay, grain and roots from the natural fertility he induced, rather than from an artificial fertility produced by manure and feeding stuffs.

From his point of view his methods were a success, and his seed mixtures gained a very considerable amount of popularity. Mr Elliot's end was attained, in that, when the Clifton five, six or seven year old pastures were ploughed, the crops were good; they stood the drought on the gravelly soil, and in the warm, dry climate of the Bowmont Water Valley; there was plenty of quickly decaying vegetable matter from the unusually long time in grass and the system of cropping, which was to rot the turf by taking a root crop first. Mr Elliot's system seemed good for the farm and country in which it was carried on; it was, in many ways, excellent. What was, perhaps, most in evidence was the luxuriant hay crops, and very abundant red clover.

But in the production of a pasture, suitable for the bringing out of the ordinary classes of farm stock for market, it hardly seemed so successful. From almost yearly visits to Clifton-on-Bowmont Farm, I got the impression that the system was more favourable for a dairy farm, or, at all events, one in which cattle were predominant, than for sheep farming.

With a country generally so suitable in almost every respect as is the south-east border country of Scotland for either the lowland or the mountain breeds of sheep, it is unlikely that the methods and system now in vogue will be materially altered. But it does not follow that the details of the working of the present system are, in every respect, the best. Many of the farmers have been shepherds themselves when younger, and have learned the rules and precepts of that calling, perhaps, in some cases, only too well. Shepherds are, as a rule, a fairly intelligent class, though, for the number of years that I have farmed, my experience of different types has not been large, but they are, undoubtedly, very conservative in their business, whatever their politics may be, and it is somewhat difficult to get the average shepherd to take up anything new, and to admit that there can be anything wrong with their preconceived views as to sheep. (As an instance, how many shepherds are there but believe most emphatically in telegony, after all the proofs and demonstrations that have been made against any such theory.)

A shepherd is a sheep-herd, and most of them are unwilling to have anything to do with cattle. Even some of the best consider that to give a look at the cattle in the field occasionally as they walk their rounds, is beyond their sphere, even though they may have been hired to do so. This I have found to my cost more than once. Shepherds, naturally, have a great deal to say in the management of a sheep-farm, and as I have said, very many sheep farmers are of similar training. Even when they are not, it is often thought to be a gross error for the farmer to have any opinion of his own opposed to that of the shepherd.

About six years ago the Board of Agriculture for Scotland conceived the idea that, as arable farmers were being asked to cultivate and crop more land with a view to increased grain production, the sheep farmer should be asked to do something with a corresponding object. The East Border district was considered specially favourable, and a number of prominent farmers from that district were asked to meet and consider how far it would be possible to increase the grazing and breeding of cattle and growth of winter keep on the hills and hillfoots without materially affecting the sheep either in numbers or quality. Eventually, a large committee was formed, with which, as an interested party, I was connected. Meetings were held and visits made in various parts of the district, addresses were given by members of the Board, farmers and others; the meetings were well attended, and it seemed as if the arguments used were having weight; and that the phosphatic manures, supplied by the Board of Agriculture to demonstrate how the crop of meadow hay could be largely augmented, would result in a considerable increase in the numbers of cattle bred and grazed on many of the hill pastures. That there was a considerable increase both in the numbers of cattle and in growth of hay as the result of this propaganda is certain. But, owing to various causes, among which may have been the influence of the shepherds, which was sure to be unfavourable, the unsettled position produced by the cry for the removal of the embargo on foreign store cattle, and the removal of the acute conditions prevailing before the Armistice, there is, I fear, not now much permanent increase. It is as an effort to resuscitate interest in the matter and to achieve some permanent result that this paper has been written.

In the seventies, as described in a former paper,[1] I drained, limed and broke up about 600 acres from heather and mountain land at a height of from 800 to 1100 feet. It was found to be deteriorating pretty considerably with the lapse of years and constant grazing with ewes and lambs, and generally the herbage, instead of showing any of the grasses and clovers which were sown was almost entirely "Agrostis" (Moorbent), with some other equally worthless grasses, and some small, weak, wild-white clover plants, struggling to maintain existence here and there.

With regard to the stock, while there was plenty of roughness in the pastures on which they grazed, they had a fair existence without much betterment, but the chronic difficulty of having insufficient winter keep for the number of cattle that could be grazed on the farm in summer annually presented itself. This, coupled with the practical impossibility in average years of buying in spring and selling again in autumn at a profit, made the need for some other system imperative.

About thirty-five years ago the breeding of cattle on a fairly extensive scale was adopted, with the expectation that by suckling calves and selling them in autumn the difficulties would be met. With this object in view I got a small pedigree Shorthorn herd to breed well-bred bulls. So as not to clog the experiment by over capitalisation to start with, I bought a couple of scores of Ayrshire heifers, which could be got at from £6 to £8 per head at the time. During eight or ten years I found this class of stock do only fairly well, although replenished by the purchase of ten to fifteen youngsters every spring.

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[1] *The Scottish Journal of Agriculture*, Vol. IV., No. 4, p. 373.

So long as the farm servant householders kept cows of their own, I could generally count on getting a fair return for the cow. This system, however, had to be abandoned, as (first) the suckled cow was found to be a poor milker in many cases; (second) the farm servants gave up keeping cows on any but a small scale; and (third) the cross calf, I found, came all colours, some grew, some did not; some had horns long and noses black; some did well, some not. In most cases, therefore, prices were unsatisfactory, but before the Ayrshire was given up the suckling of two calves by each cow was tried. This was a failure also, as, on so large a scale, it took too much labour, and the Ayrshire, accustomed to be outside for eight or nine months, was not a very amenable animal, while to have calves always ready to put on took some buying when done to the extent required. The real difficulty of the Ayrshire was the very unsatisfactory nature of the average Ayrshire-Shorthorn cross calf from the usual east country buyer's point of view.

For some years I tried Cumberland Shorthorns with an Aberdeen-Angus bull with varying success, which depended largely on the mildness or severity of the winter season. The calves of this cross sold well, the cows milked well, better than the Ayrshires, and were good doers and quiet, taking two calves with little trouble. The weak point was the wintering out, which was not practicable in the prevailing winter weather. I consider that in the end I have now succeeded in getting the cow, which meets practically all the conditions, in a big, roomy Cumberland-Galloway. I admit that the proper type is difficult to obtain as, for crossing, I have found they must be pure. The difficulties are (first) to keep clear of the Ayrshire-Galloway cross which (the late Dr Gillespie notwithstanding) I have satisfied myself does not always produce the class of calf you want and the best customer wants; and (second) to have the bigger class of the pure bred cows, which, even though I latterly bred my Galloway heifers myself, was not always possible.

It has often in the past been difficult to compete with the north-west of England and Ireland in breeding store cattle, but there is most room at the top, and up to this time the blue-grey Galloway-Shorthorn steer is very near the top. It perhaps does not quite come up to the Angus-Shorthorn, but the consideration that it can winter out almost as well as its mother, and the difference in the cost of keep of the two will easily keep the Galloway cross for the additional year which is required to make the two equally mature. Generally, however, I found the Angus cross unsuitable for my purpose, whereas the Galloway cross was markedly suitable.

My forty-five to fifty-five Galloway cows and heifers are never in the house, except for the week or two it takes for handling the somewhat wild Galloway calves, until they are reasonably quiet. My treatment is to give a little hay when snow is on the ground and always from about February 1st; and an additional 3 lbs. of cotton cake, bran, or grains (whichever is cheapest) a month before they calve, say, from the third week of March till the grass comes. They calve outside, and unattended, after the middle of April, and the loss is infinitesimal, averaging less than two calves a year, and one cow in three years. Some of the later calvers, after the grass has come, have too much milk and occasionally have to have two calves put on, which is not difficult. I found them much better mothers than the Ayrshire or pedigree Shorthorn. The eild cows are a negligible quantity, and are always fat in autumn off grass.

Like most people I soon learned that where sheep are grazing year after year there are very distinct advantages to be derived from having a few cattle along with them. But it took much longer to find out the full benefit of cattle grazing, and it is only during the last eighteen years or so that I have practised what I term a system of "Rotation Grazing." The special features of this are, that one year out of five the pasture should graze nothing but cattle for about four months—that is, the period of maximum growth. It should be stocked as early as possible, and fairly heavily, since it is always growing up to the stock. Another feature is that, as far as possible, a pasture should have periodically a rest from ewes and lambs, and that hoggets alone should form the stocking for one of the six years.

My 600 acres odd of broken-up heather and mountainland is still in six fields of about 100 acres each, so that the rotation has been roughly as follows :—

1. Cheviot ewes and lambs.
2. „ hoggets.
3. „ ewes and lambs.
4. Cattle.
5. Cheviot ewes and lambs.
6. Hay, and mixed stock when possible.

The field in the sixth year of the rotation has been variously grazed, but, when possible, has always had cattle and horses among the sheep, and when ewes and lambs had to be grazed on it they were never the same individuals as grazed it in the previous year. Generally it has been more lightly grazed in the early part of the season, and this has been of great value in the case of midsummer droughts. Also, owing to being lightly stocked, there was in most years a good cutting of hay on the rougher parts. As a rule, after the middle of September, the fields may be stocked as the shepherd sees fit, but before that I have always liked to see them stocked on the above-mentioned lines.

The purpose of this differential grazing is simple enough, and the results arise from the different habits of the animals. Cattle require a longer pasture than sheep, and cannot crop the grasses so closely, neither do they to the same extent select their special titbits as sheep and horses do. The result is that in the cattle-grazing years the more tender and the finer grasses—which are the more assimilable by all animals—and especially the wild-white clovers (whether sown or natural), get time and scope to develop. This is particularly the case in the early part of the grazing season, and is very evident even to quite a casual observer. Further, grazing with cattle affords almost the only chance of getting the rougher, stronger herbage kept in check, and when one considers the double advantage of developing the fine plants and keeping down the coarse ones, one cannot but strongly recommend grazing with cattle alone for the first four months of the grazing season for one year at least out of every six.

The roughness can be kept down in a way by grazing some cattle along with the sheep at any time, and that is certainly advisable if the pasture has a tendency to get coarse. The best way to get quit of roughness (which some people seem to like calling it "winter meat") is to put on cattle in winter when there is not much else to eat, but for this you want cattle like Galloways that can stand the changeable climate.

Ewes and lambs not only crop closely but they select their food with great care. The result is that on being put into a field they go for the clovers and sweetest and finest grasses first, and only take a bite at a cocksfoot or other stronger plant as they go past. Thus it is easy to understand the deterioration which takes place in a grazing, stocked constantly year after year with ewes and lambs, and for three or four years running by the same individual ewes. That the general deterioration is not more recognised is largely from want of observation.

The advantage obtained from alternating the grazing of ewes and lambs with hoggets and other young sheep requires to be gathered by closer observation. But it is there all the same, though probably to a lesser extent. To change the individual sheep from time to time is a distinct benefit to the pasture, and very little, if any, harm to the sheep.

I have been talking mostly of the treatment of what I might call hill permanent pasture rather than ordinary mountain-land grazing. There are many parts of our hill grazings to which many of my remarks may be applied; and while sheep may be better payers for their keep, or at least give less trouble to the farmer, I am no less convinced now than I have been that many of our Cheviot and Lammermoor hill farms would be the better of many more cattle than they are at present carrying.

I have not touched on the seeding of the land that is being returned to grass and pasture, because I don't think it matters much. One certainly wants wild-white clover and a few ordinary grasses, according to the individual fancy of the farmer or his seed merchant. But long before the field, seeded down now, becomes a good, permanent pasture it will have made its own selection, and comparatively few of the plants produced from the seeds sown will be found, and those for which most has been paid will perhaps not be there.

ON PINING, VINQUISH OR DAISING IN SHEEP.

J. P. McGowan, M.A., M.D., B.Sc., *The Rowett Institute, Aberdeen*; and W. G. Smith, B.Sc., Ph.D., *Edinburgh and East of Scotland College of Agriculture.*

Early History.—The subject of this paper may best be introduced by the classical account of it given by Hogg, the Ettrick Shepherd. His description refers to the main characteristics of the disease, though it may be found later that the views expressed by him require modification.

In a paper published in 1831 (*Quarterly Journal of Agriculture*, Vol. II., p. 697) he writes as follows:—"The most destructive and ruinous disease among sheep at this time over all the South of Scotland is that called pining. Well may I describe it, for in the course of the last nine years I have lost upwards of 900 sheep by its ravages. It is quite a new disease on the Borders for I was twenty years a shepherd and never saw an instance that I can remember of with certainty, nor did I ever hear its name save from Galloway where it is called 'The Vinquish' and where it has been prevalent for ages. It was likewise known long ago in some of the districts of the middle Highlands.

"It is a strange distemper. On the genuine pining farms sheep do not take it by ones and twos, but a whole flock at once. It is easily distinguished by a practised eye, the first symptoms being lassitude of motion and a heaviness about the eyes indicating a species of fever. At the very first the blood is thick and dark of colour and cannot by any exertion be made to spring; and when the animal dies of this distemper there is apparently scarcely one drop of blood in the carcase. It lives till there does not appear to be a drop remaining and even the ventricle of the heart becomes as dry and pale as its skin.

"It is most fatal in a season of drought and June and September are the most deadly months. If ever a farmer perceives a flock on such a farm having a flushed appearance of more than ordinarily rapid thriving he is gone. By that day eight days when he goes out to look at them again he will find them all lying hanging their ears, running at the eyes, and looking at him as so many condemned criminals. As the disease progresses the hair on the animal's face becomes dry, the wool assumes a bluish cast; and if the shepherd has not the means of changing the pasture, all those affected will fall in the course of a month.

"In 1823 I chanced to go to the hill one morning in June, not the least aware that the pining had set in and found upwards of twenty score far gone in it and new ones getting affected every day. This was a cheering discovery. What was I to do next? I went and took two fields of young clover and changed the stock on these every fortnight which I believe saved a part; but in spite of all I could do, I lost fourteen score of them.

"There is only one effective cure known in this country, which is a change of pasture to one of more succulent herbage. This is a certain remedy when resorted to in time; and if the sheep are laid on clover or limed ground the cure is the quicker. If ever the bowels are open and marks of a slight flux appear then the animal is safe and the necessary change has taken place in the constitution. Nevertheless these sheep will be the first to take it again. They are sure to take it again either that year or the next; so that upon the whole a farm cannot be subject to a more ruinous distemper. Few of the ewes that are affected in autumn have lambs next year or they have them far too late to be of any value.

"The farms most liable to the disease are those deep grassy farms which were in former years wholly overrun with mole-hills; and which farms are intermixed throughout with great flats and ridges of white and flying bent. These last are the bane of the flocks when the surrounding bogs are not rich and succulent enough to counteract the costive effects of the other; and exactly in proportion as the. succulent and laxative herbage prevails over the dry and benty, the effects of pining will be less felt. On steep and rocky lands, where the herbage is sweet and short the disease does not exist; and on hard heathy lands which are generally intermixed with green little strips called gairs, it is scarcely known, but there are few of these deep strong grassy farms, which prevail so generally over the southern districts of Scotland, on which there are not some parts which have to be constantly watched and the sheep turned from them pointedly once or twice every day else the pining is sure to make its appearance. Thus in dripping seasons shepherds by strict attention in changing the sheeps' pasture every day may in a great measure prevent its ravages; but in a dry season, without infield land sown with succulent grasses or limed, it is impossible to prevent it.

"It has always been my opinion and the opinion is general among shepherds that the extirpation of the moles was the primary cause of it; but having mentioned that in a former paper (1807) I need not insist on it here.

"The pining is not infectious. Although the amazing rapidity with which it spreads among some flocks might lead to the conclusion that it was as contagious as fire, yet after dear experience I am convinced that it proceeds wholly from the food; because on land where it is but partially known and little regarded a straggling sheep will take it and cling to its dry costive spot till it dies and yet none of the rest be affected by it. The lands that are now most liable to this disease were once in the same manner liable to the rot. But gradually as the draining of the sheep pastures proceeded the rot was extinguished. Then to preserve the drains the moles were extirpated and ultimately the rot was superseded by the pining."

Hogg, in an earlier paper (*Shepherds' Guide* 1807, p. 68), refers to the disease under the names of pining, daising and vinquish. He states that it is commonly caused by a sudden advancement in condition of the sheep on coarse heathery and mossy soils, where heather, "draw-moss" and "deer-hair" [1] when young, fatten sheep amazingly. To prove that the finer breeds of sheep are less liable to this disease than the Black-face breed, Hogg mentions farms in Galloway where the disease was so prevalent in the autumn months that heavy losses were only prevented by changing the stock to finer and drier pasture. Later when the same farms were taken by farmers from the east country and stocked with the Cheviot breed, scarcely a single instance of this disease occurred. He also states that most east country farmers who have moory and mossy farms regard a change of pasture as necessary in July, August and September.

In connection with Hogg's paper in the *Quarterly Journal of Agriculture*, the Editor of that paper (Vol. II., p. 706, 1831) also refers to the subject. He states that the principal districts, where this disease prevails, are the green pastures of the Cheviots, the hills running through the south-western parts of Roxburghshire, the pastorial districts of Selkirk and Peeblesshire and some other districts in Scotland, including Galloway. He also states that "pining" was unknown in most of the districts when the old practice was followed of weaning the lambs in July and August, and afterwards milking the ewes for eight or ten weeks. When, however, the farmers changed this practice and allowed the lambs to remain until they weaned themselves in December, "pining," according to his statement, increased especially on astringent pastures such as those on the syenitic porphyry of the Cheviots. He gives it as his opinion that the disease is more common in dry than wet seasons (a view opposed to that now held commonly); and at the time of the year (late summer and autumn) when herbage is less juicy. He points out that it is not known on the Lammermuir Hills (clay slates) where the hirselling practice as above noted is current, and where the pastures are heathy interspersed with green patches. Nor is it found on heath or green pastures on a calcareous or sandstone formation. He avers that Cheviot sheep are more subject to pining under the same circumstances of feeding and treatment than the Leicesters. He makes this statement on the authority of a farmer on the Cheviots who stated that on some of his farms with one portion of his sheep Cheviots and the other a cross nearly allied to the Leicester, he had frequently observed a great part of the Cheviot sheep affected with pining, while not a single one of the other breed would show the slightest symptom of the disease though they pastured indiscriminately together. He quotes from a communication from Mr Laidlaw, Bowerhope, Selkirkshire, anent the supposed relationship of moles to the disease. In this Laidlaw states that prior to the more or less general draining of hill farms moles were found only in the green "gairs," but with the extension of draining operations, the moles spread over the farms. Owing, however, to the damage they did to the drains they were more or less exterminated with the result that the green gairs disappeared and the pasturage become more benty. He gives instances of farms where the occurrences noted took place and where the destruction of the moles was followed by pining among the sheep. This pining, he adds, disappeared, however, when the moles were again allowed to become numerous. (In this connection, while we admit the beneficial effects of moles on hill pastures, we are unable to believe, from our knowledge of the disease as it occurs to-day, that they can be accorded the prominent role in regard to pining assigned to them by Laidlaw. Their operations undoubtedly are in the direction of preventing pine and might on farms very little addicted to the disease turn the balance. It is difficult, however, to see how, on some of the farms we are acquainted with, they could operate on such a scale as to eliminate the disease).

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[1] Draw-moss is the south-country name for cotton sedge (*Eriophorum app.*), deer-hair is tufted club-rush (*Scripus cæspitosus*).

These extracts include the more important items in the older literature, and any subsequent references we have found are obviously taken from these earlier papers. It is unnecessary therefore to refer to them further here.

We turn now to a consideration of the disease as it occurs at the present time. During the months of July and August 1921 we had the opportunity of examining a series of farms affected by the disease in the aggravated or endemic form. These farms, highly typical of the surroundings under which the disease occurs, were situated along the Scottish side of the Cheviots. The results derived from this investigation are here summarised.

Symptoms.—The symptoms exhibited by the pining sheep are not striking except in the advanced cases and are best understood by a comparison of the affected individual with the other members of the flock. Thus it is often observed as the first sign that when the flock is being driven out, the pining sheep tends to lag behind the others. It is unable to follow, is very short of breath and, if "dogged," often comes to a standstill. Eventually when the disease has advanced somewhat further it makes no attempt to move but lies still in one place, even when urged somewhat vigorously. These features of the disease are seen on a large scale sometimes when considerable numbers have become affected and it has been resolved to send the sheep away to another farm for a change. The weakness of the flock as a whole at this time may be so great that they can hardly be driven off the ground.

In the aggravated condition of the disease, the sheep, in addition to being breathless and weak, are noticed to be very bloodless, the insides of the lids and the whites of the eyes becoming like chalk. There is a discharge from the eyes, and the secretion mats together and dirties the hair of the face, which already has the appearance known as "staring." The fleece, as a whole, becomes hard and dry in texture and blue in colour; the belly dwindles and eventually the animal becomes so emaciated as to be aptly described as "skin and bone." There is no febrile disturbance, no diarrhœa, and no "poking" under the jaw. If constipation exists it is not a marked symptom. The animal continues to feed greedily even up to the end, but as the shepherds remark its food does not appear to do it any good.

The post-mortem examination of pining cases shows nothing characteristic. The only appearances found are extreme emaciation and bloodlessness with, in certain cases, the evidences of intercurrent disease. Intestinal parasites and liver flukes cannot be regarded as having to do with the causation of the disease, because none may be present in typical cases.

It is interesting to note that, in reference to the diagnosis of the condition, the "West-Country" shepherds, who are unfamiliar with the disease, when they see this condition in the ewes with lamb in the endemic area in the summer time, think it is a case of "sookit-doon" or debility from suckling the lambs. The disease, however, is not of this nature, but is of much graver import.

A few more facts may now be given with reference to the natural history of the disease. It affects all ages of sheep, and it is to be noted that the lambs when they are attacked are as big in the bone and as well-grown as lambs reared elsewhere. There is thus no retardation of growth until symptoms of the disease manifest themselves. The rapidity of onset of the disease is also noteworthy, and there does not appear to be any preliminary trouble leading up to it. Sheep and lambs, apparently in the best of health and doing well, are suddenly attacked by it. The sheep may, so to speak, apparently be healthy to-day and a declared case of the disease to-morrow. Following on the attack the animal may die in a few days, but in the great majority of cases they go on existing for weeks and months. If the cases are observed early and removed to a pasturage that provides a suitable change, they get well again in a few weeks and may be returned again to the old pastures where they will remain well and thrive for months. If, however, the disease is allowed to progress until the emaciation and weakness become marked, the change to a new pasturage may not bring recovery, or, should it do so, the recovery is much slower and may extend over a year.

It is difficult to say at what time of the year the disease is most prevalent, because on all pining farms the stock is changed to new pasturage once or even twice in the year, a custom which introduces complicating factors in determining this point. It seems, however, that in actual practice the most prevalent period is from March to August, that is during the season when food is most available. Hence the disease cannot be explained by a suggestion of simple starvation. In this connection the disease as it occurs among lambs is worthy of notice. They usually begin to develop it about the end of July or beginning of August. There is consequently at this time some anxiety as to whether the lambs can be kept in condition for the lamb sales, and this is greater when the sales come late. Nevertheless, the lambs from these pining farms may be amongst the best that appear at the sales if pining has not set in. It may also be mentioned here that the ewes on these farms when managed properly have as large a crop of lambs as ewes on non-pining farms.

As regards the gravity of the disease, it is a common belief, justified apparently by experience, that on these pining farms the whole stock would die out in less than two years if they were kept constantly on the ground.

Influence of Soil.—Pining probably exists more or less in all the districts mentioned by Hogg and others in the *Quarterly Journal* in 1831. The Cheviot area seems, however, to be the best known at the present time as a centre where pining exists in endemic proportions. During our enquiries there, emphasis was always laid on the occurrence of the disease on farms situated on the porphyritic rock (a considerable area on the Geological Survey map), lying on the Scottish side of the Cheviots and extending southwards, especially in the Coquet valley. There is also a general opinion that the change of grazing, already referred to as a preventive of the disease, should be made from the porphyritic rock to the pasturage situated on sandstone or limestone Our experience as regards soils, however, does not support the general belief. Thus the majority of the farms in the Cheviot area are situated on or near the porphyrite, but all these are not pining farms. Indeed the pining farms which we know of do not number more than a score out of many farms that rest on the porphyrite formation. Further pining hirsels occur on some farms, where the grazing is not over porphyrite, but over sandstone. Again, the disease exists now, or did exist about 1831, on other types of soils. Thus, for instance, several of the localities mentioned at that time as being subject to the disease lie over the Silurian rocks that extend further west from Selkirk and Peebles into Galloway. The more the distribution of this disease is examined, the more it becomes apparent that pining is not limited to any special type of rock or soil, and that the cause of the disease must be sought elsewhere.

Herbage.—Special attention was given to the farms examined to ascertain whether the pasturage showed any special features that might throw light on the occurrence of pining. The typical porphyrite hill has an abrupt peak with a rather narrow ridge or top, so that it is fairly easy to identify. The slopes show exposures of loose fragments of a reddish rock weathered into angular pieces, some larger, but mostly small. These hills are frequently covered with fine herbage, closely grazed. The most abundant grass is a fine-leaved variety of Sheep's Fescue (*Festuca ovina, var. tenuifolia*), closely tufted and with short ears. Amongst this is a certain amount of Bent (*Agrostis*), Yorkshire Fog (*Holcus lanatus*), Sweet Vernal (*Anthoxanthum*), and these tend to form patches with much less evidence of grazing than the Fescue. The amount of ground covered by the fine-leaved herbage and the "benty" herbage varies on different hills. As a rule the fine-leaved herbage occupies the summits, while the "bent" comes lower and tends to increase on descending the hills. Towards the bottom of the steeper slopes of these porphyrite hills, the rotten rock ceases and there is a change in the herbage. This line marks a seepage or outflow of water that has percolated through the rotten rock above, and comes to the surface either where the rock changes or where there is a coating of boulder clay. The herbage of the lower slopes is that of moister land. In the wetter places rushes and sprets (species of *Juncus*) form patches, and sedges (*Carex*) mixed with grasses are found on the wetter "green gairs." These are of a deeper green than the lighter "fescue" and "benty" summits. Bracken fern is not uncommon on the drier "gairs" or grassy places. Another type of herbage has a soil more peaty, or it is a deep turf accumulated over badly drained boulder clay. Here white moor-grass (*Nardus stricta*) predominates with or without blow-grass (*Molinia*), and generally mixed with bent (*Agrostis*) and wavy hair-grass (*Aira flexuosa*).

It was noted in July 1921, about the break of an unusually severe drought, that the fine-leaved fescue herbage of the top was everywhere closely grazed, whereas the rushes, sedges and the moory herbage with Nardus and Agrostis showed little evidence of grazing, except about the margins of patches. In such a dry season it might be assumed that the stronger herbage on the moister soils would have been more frequented by the sheep, but there was not much indication of this, though it is probable that a certain amount of grazing of the lower surface herbage may have taken place.

With reference to what is said later as to the advantage of a change of pasturage on to heather, it was interesting to find that heather of a kind may occur on farms more or less subject to pining. In one instance, on the boulder clay land below a series of typical porphyrite ridges, there was a considerable extent of heathery land with abundance of short heather, but the tenant did not consider that this heather was sufficient to counteract pining. In another case, the hill carried considerable tracts of heather broken up by grassy gairs or by rougher herbage. The fine-leaved herbage on the summit was not extensive. This hill was known to be subject to pining, but the disease could be kept in check if the sheep were kept moving by careful herding. Another porphyrite hill (referred to later in the description of a "hogg-hirsel") could be described as a heather hill, for seen from below the steeper slopes are strongly heathery, but there is an extensive summit of moory white-grass and bent. On this hill little of the fine-leaved fescue herbage was seen; this is a distinct "pining hill," and experience with it is dealt with later.

There is a general agreement amongst shepherds that the waterhead farms are free from pining. These are generally more mixed in herbage, and the variety of herbage is more accessible to individual sheep in their "beats." These shew fresh grassy pasturage about the stream heads, giving place upwards to heather, white-grass (*Nardus*) or blow-grass. The higher water-shed parts of these farms are on peat, carrying heather, blacberry (*Vaccinium*) and drawmoss (*Eriophorum*).

So far as the vegetation *per se* is concerned, it would not be easy to recognise a pining farm. The following features of the herbage, and its distribution, however, would indicate conditions favourable to pining :—

(*a*) A large area of fine-leaved fescue grass on steep abrupt tops;

(*b*) A small amount of green inflow land about stream sides, or an arrangement of the fencing that prevents sheep grazing on this herbage;

(*c*) Absence of drawmoss (*Eriophorum*) on peat, and of heather on peat;

(*d*) A large amount of "white ground" with white grass (*Nardus*).

This latter is a type of herbage generally regarded as conducive to pining, and is specially mentioned by Hogg in this connection.

Influence of Season.—This subject has been dealt with previously, but may be touched on in more detail here. Pining is more evident during the growing season of the pastures, that is March to August. At that time of year the sheep pass most of their time on the tops, whereas in winter they are compelled by weather to utilise the lower pasturage, including the green gairs and flow-land. On the average, pining is said to be less prevalent in a dry and more pronounced in a wet year. Our observations in July and August 1921, at the close of a prolonged drought, showed the fine-leaved herbage on the tops of the steeper hills to be droughted and closely grazed down. On the other hand, the lower green gairs and flow-land on moister ground carried a considerable growth of herbage which was not much grazed except round the margins. It would appear that in a dry year the sheep persist in grazing the shorter herbage of the tops, but when it becomes droughted and short they are obliged to frequent the coarser herbage of the lower ground to some extent. All the more is this the case if the herding is carried on so that they are compelled to come off the tops. This better utilisation of the herbage with a consequent greater variety in food is, in our opinion, the chief reason why pining is less in a dry year.

Change of Pasture in relation to the Disease.—The usual preventive for pining is to send the sheep away, and in the porphyrite area the preference is for a change to sandstone or limestone. Most reports say that hard heathery ground is preferred, and this is more likely to be found over sandstone than over limestone. The usual change is southwards into Northumberland, and the sheep are away for about ten days. As a rule the sheep are moved before the disease is evident. As showing the efficacy of this change even of such a short duration, cases were cited where the sheep when sent away were so weak that they could hardly be driven off the ground, whereas when they returned they were active and not easily restrained even by the dogs. It would also appear that the pasturage where they are sent is poorer than their usual grazing because frequently on return the sheep have lost condition. So much is this the case that in one instance a shepherd from the west country, after observing the poor condition of the sheep on their return, refused to send his "pack" for the change, with the result that they all died of pining.

In this connection some evidence was obtained that a change of farm could be avoided and a prevention of pining effected by other means. Cases are known where pining was avoided by transferring the sheep regularly to improved grass-land on the same farm. Sheep actually attacked by pining can be cured by putting them on the better herbage on parts of the farm that have been cultivated and improved. Evidence was obtained that changing the sheep from one pining farm to another gave good results. Another line of treatment recommended as useful is to keep the sheep moving over the ground by energetic herding, and it is locally well-known that a pining farm requires an unusual amount of "dogging." The operation, as described, should be timed so that the sheep are allowed to feed on the herbage of the tops in the morning instead of being herded down early. Later in the day they are put down into the rougher "flow-ground." The reason given is that if the sheep are driven down into the moister herbage early in the morning they feed little there, but begin almost at once to move up the slopes again towards the drier tops. There is thus considerable support for the view that a change to a long distance—*e.g.* Northumberland, is unnecessary. The benefit which results from this distant change is probably due to the sheep, unaccustomed to the new ground, ranging more over it instead of limiting their grazing to certain types of herbage on it.

Distribution of Pining.—Though pining of whole flocks is most marked on farms of the kind already described, it is also widely distributed as isolated cases in flocks elsewhere. The disease is thus known amongst lambs in various districts away from the recognised pining areas. On many farms the lambs cannot be kept on the ground after August. In order that the business of the farm may go on, they have to be sold and fresh lambs brought in. The lambs on the "dead side" of a hill on certain farms in non-pining districts are said to go badly with pine about August. If they are not too numerous some farmers put them amongst growing turnips, where, by feeding on the weeds, turnip leaves, and succulent grass, they become sound again in a short time. This and other evidence indicates that pining in a modified degree may be looked for in many districts other than endemic districts. This sporadic occurrence of the disease is referred to by Hogg (v. *supra*).

Influence of Nutrition.—A consideration of the various factors, soil, herbage, season and change of pasturage, and other evidence, suggests to us an explanation of the disease not hitherto stated. Briefly, it is that the sheep on pining farms limit themselves to certain parts of the pasturage, and will not feed on the rest unless compelled to. The result is that their range of feeding is limited, hence they do not obtain sufficient variation, their diet is insufficient and monotonous, and pining follows. The disease is not due to lack of plenty of food, because it is more evident in the growing season, and not in the harder winter conditions. In one instance, horses were grazing on the same hills as the sheep, and the owner knew of nothing resembling pining in them, though he had pastured them for years. Nor was there any evidence that cattle would not do well on a pining farm provided there was enough "green land," since young cattle utilise the rougher grassy herbage better than sheep. We have discussed with the shepherds the question of overstocking pining farms with sheep and of adding cattle, and the general opinion is that this would make the sheep wander more in search of food, and that increased stocking would improve the pasture by reducing the amount of rough herbage. In this connection it may be remarked that the routine of one farmer for coping with the disease was to overstock the farm deliberately so that the sheep would have to work for their living, and thereafter to send them away for a change.

Arrangement of Hirsel.—The "hirsel" is a range of pasturage occupied by one group of sheep, and each hirsel is a unit in itself, so that sheep from one hirsel confine their grazing entirely to their own range of herbage. Most hirsels are of old standing, the boundaries being rarely altered, and the number of sheep per hirsel is arranged by the stockholders according to their experience whether a hirsel will carry many or few sheep. An ideal hirsel of land should offer a complete range of herbage such as is available for the district. Thus, for example, it might range from the grassy inflows and gairs of the stream sides, through heather of the hill slopes, and up to mossy peat-land (drawmoss, heather, blaeberry, etc.), and perhaps (as in the porphyrite) to grassy hill-tops. Naturally, this cannot always be obtained, because hill land varies so much both in herbage and "lie of the land." The differences between hirsels is well known, and can be confirmed by the examination of the prices at the yearly sales.[1]

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[1] The relation between prices and herbage was included in a recent survey of hill farms conducted by the Edinburgh College of Agriculture. From details collected from a number of hirsels about Tweedside, it was evident that good quality in sheep depended much on a mixture of herbage in good grazing condition. The higher prices are obtained for sheep from hirsels with a considerable proportion of infall land (flush and stream-side grass land), good heather, etc. Low prices go with a large proportion of inferior herbage, especially white grass (*Nardus*) heather in poor condition, and with certain kinds of dry benty grass land. A good hirsel may sometimes include a large amount of inferior herbage, say white grass, but this weakness can be discounted by a sufficient extent of the better herbage. The relation is not always a simple one, and it is probable that much depends on how the sheep utilise the herbage, a point emphasised in the present paper.

In the case of pining, it is possible that the disease may be favoured by a badly arranged hirsel of land where some items of useful herbage are entirely wanting. In our examination this aspect was kept in view, but there was no reason to believe that pining arose in this way. In one instance there was a relation between pining and the defects of an exceptional hirsel. A hirsel of 500 acres is used as a "hogg hirsel" for about 600 ewe-hoggs. Owing to the lie of the hirsel it includes almost no grassy infall to the neighbouring streams. The east side is steep with short heather on thin soil which comes nearly to the burn on that side. The other side is a longer slope, but the sheep of this hirsel are fenced in on that side so that they cannot get down to the burn there. The top and sides of this ridge carry thick Nardus (white grass) pasture which has little evidence of being grazed. Northwards the end of the ridge slopes downwards and the Nardus descends low, but here again the fencing round the home fields prevents access to the grassy herbage where two streams meet. Southwards the ridge continues on to higher land, but owing to the hirsel-planning the sheep of this hogg-hirsel are within a fence running across the ridge. The whole ridge hirsel carries mostly rough Nardus (white grass) pasture, or heather, with patches of other poor herbage. The sheep in this hirsel are ewe-hoggs, reared on the other part of the farm, speaned (August), sent away for a change as a preventive against pining; on return they go to this hogg-hirsel for the winter. (In this way they are strangers to the hirsel, and not in the position of lambs raised there under the guidance of their mothers, and so better fitted to make the most of the herbage, such as it is). By June this hirsel shows signs of pining, and the sheep are sent away for a change. One year the ewe-hoggs were not sent away, but kept on the same farm, being taken across the fence to the end of the ridge where it rises up to waterhead land. They did not range about, but simply hung about on the ground, next to their own boundary fence. If driven higher out they soon returned, hence they did not benefit from the better pasturage which the rest of the farm provided and which was of a non-pining nature. The consequence was that pining set in, and they had all to be sent away in September for the usual change. The rest of this farm can be kept clear of pining by good herding. The highest part consists of mossy land, with heather and draw moss (*Eriophorum*), below this is a belt of Nardus, and lower still a green belt with extensive grassy flows round the stream heads. The herbage thus differs considerably from the confined "hogg hirsel" just described, and evidently it supplies better nutrition for evading pining. In the case of the hogg-hirsel a readjustment of fencing is obvious, but under the conditions of ownership, etc., there are considerable difficulties in the way.

Prevention.—Various means for preventing the disease have already been indicated. A regular change of pasture seems to be effective because the sheep are turned on to unfamiliar ground where they range about more and thus obtain a more varied diet. The same variation may be secured by increased herding on the home hirsel. This may consist in changing the time of the morning herding so that the sheep are allowed to feed longer at that time on the "tops." On changing thereafter to the lower ground they stay longer and make more use of the herbage. Increased "dogging" will also make the sheep range wider. This was illustrated in the hill of mixed herbage referred to above, including heather, where with careful herding, pining could be avoided and the sheep need not be sent away. The beneficial effects of a change on to improved land have also been referred to. Here better herbage has been raised by top-dressing with lime, etc., or after a course of cropping. There is also the possibility of adjusting a defective hirsel so as to give greater variety in herbage. An instance of the beneficial effects from such measures is given in a communication from a well-known agriculturist in Selkirkshire. On a farm on the Silurian, away from the Cheviot area, with which he is well acquainted he reports that if a certain cut of sheep were not regularly driven in they would develop pining. A change into the fields is sufficient to keep the disease in check. The same correspondent also gives the result of adjusting the hirsels: "On the same farm the putting of two cuts into one made a grazing which extended from the bottom to the top of a hill; this gave a greater change of meat every day and it cured the pine."

Cure.—As regards the curative treatment for sheep actually attacked by pining, some useful information was obtained. A close watch is kept for sheep with the earlier symptoms, and as soon as observed they are usually removed to a field, preferably young grass, when recovery usually takes place rapidly. Such a field is usually in practice situated at some distance and away from the hilly districts. Several instances were found, however, where sheep thus attacked were cured by turning them on to grass on recently improved land on the same farm and on the same geological formation. Some shepherds were doubtful whether this was enough, but what was cited as "improved land" in these cases may have been improved so long ago that any benefit to the herbage has long since passed off. The treatment of pining lambs by putting them in a field of turnips has already been referred to. Another point gathered in our enquiry is that sheep can be kept all the year on pining farms, without any change to other pasturage, if they get a regular ration of linseed cake.

This leads to a point of view which may throw some light on pining. It is known that in animals the lack of certain essentials of diet, known as "accessory food factors," leads to bad results. The symptoms described in these conditions are to some extent comparable to those seen in sheep with pining. Experiments on various kinds of animals show that after being deprived of one of these food factors, they go on thriving normally for some time, but sooner or later when the store of this in the body is used up, the animal *suddenly* shows symptoms similar to those already described in pining. There is an affection of the eyes, a progressive emaciation, weakness and anæmia, all of which are checked when the animal is again supplied with the needful substance. Linseed cake contains a large proportion of the food factor specified here, and from cases cited it has the same effect in preventing pining of sheep as has the accessory food factor already referred to. It may be impracticable to apply this on a large scale, but in the more isolated cases of pining a draught of linseed meal and water might be tried. As a proof for or against this theory of the nature of pining it would be an important experiment and we should be glad to have details of observations after the application.

There are, however, some facts in the disease which do not fit in with an accessory food factor theory. Thus the disease occurs in the summer time when vegetation is at its best and when presumably there would be abundant food factors present. The disease also appears to be worst in wet years which is also a discordant fact. Again, all the observations on the control of pining seem to point to monotony and lack of a variety of food as being the essential factor in its causation. One knows how the habits of sheep on hill pastures become stereotyped and how each individual sheep keeps more or less to its "beat" from one year to another. Hogg refers to this peculiarity in relation to individual sheep taking the disease on farms not addicted to it. It may be that on pining farms the topography of the land induces a large proportion of the sheep to follow bad "beats" that is tracks of ground with little variety of pasturage. In support of this are our observations on sheep on pining farms keeping to the hill tops and not coming down into the "flow-land"; also the beneficial effects of herding and "dogging." The latter would appear to break up the stereotyped habits of the sheep if kept up as part of the daily routine. Of the same nature are measures sometimes applied to individual piners, such as chasing them with dogs and then throwing them into water—apparently with beneficial results.

[Our acknowledgments are due to Mr James K. Bell, N.D.A., etc., Hawick, who has stimulated this enquiry and helped in other directions; they must also be extended to those farmers and shepherds who accompanied us over the ground or otherwise gave valuable assistance.]

PIG-BREEDING IN SCOTLAND.

GEORGE SINCLAIR, DALMENY.

WHY has pig-breeding in Scotland been so much neglected? This is a question which has been asked on many an occasion without obtaining a satisfactory answer. It has to be admitted that in recent years there has been a substantial improvement, but still there is room for much more being done in the way of giving the pig the place it is entitled to occupy in the farm live-stock economy of the country.

It is perhaps no exaggeration to suggest that in almost every other line of farming the Scotsman can claim superiority over his southern fellows. But he can claim no such superiority in pig-farming. There are many in Scotland who fully realise the potential value of the pig but are handicapped in respect of their inability to find competent herdsmen to take charge. Many of the best class of stockmen in this country look upon the pig as something "common and unclean," and the day may not be far distant when we may see as many Englishmen in charge of pig herds in Scotland as there are Scotsmen in charge of pedigree cattle herds in England. Many of the farm workers in England are allowed to keep a pig for their own use, but this is not common in Scotland. This may be a mistake, for such a privilege would be an encouragement to the rising generation to take an interest in the pig with a resulting benefit to the country generally. The establishment of bacon-curing factories throughout the country would be a great stimulus to the pig-breeding and feeding industry. The few such factories that at present exist have a monopoly of the trade; and the discouraging feature of the situation at present is that when the pig-feeder has prepared and furnished the raw material for the market, and puts it up to auction, it more often than not passes into the hands of a middleman at the latter's own price, or far below its real value. The establishment of a few bacon-factories over the country, say on something of the co-operative principle, would tend in a very short time to stimulate greatly the pig trade. It has been proved that pigs can be as successfully bred and reared in Scotland as in England, if not more so. Scotland is supreme in the production of beef. That fact is established by the price of "Prime Scots" in the meat markets. Scotland is also supreme in the breeding of cattle for the foreign market, but this is not so in the case of pigs; and for this position the Scottish farmer is himself a good deal to blame.

Flesh-Producing Possibilities.—Too few farmers have ever given a thought to the weight of meat that may be provided in the produce of a sow, within a year ,compared with that of a cow. Had more regard been paid to this in the past, Scotland might to-day have as world-wide a reputation for the production of bacon as she has had so long for "Prime Scots." We fear that little impression can be made upon the present generation of larger farmers. It is to the rising generation we must look for a development of the pig-breeding industry, and more particularly perhaps to the smallholder. At present many of this class are depending for their livelihood largely on the few store cattle they can raise. The question of store cattle supplies is a somewhat controversial one at present. and need not be touched upon here, but prudence demands of the smallholder that he should look ahead. Should, under any circumstances, his revenue from store cattle become restricted, and should the selling price of meat come down 56s. per cwt.—as certain experts suggest it may—neither the rearing nor the feeding of cattle would be a profitable concern, and he might be compelled to turn his attention to pigs. It has never been suggested that Canada can send us store pigs, although she has more pigs than cattle. Canada will continue to send us pigs only as finished bacon; and might not the discouragement to breed store cattle be a blessing in disguise for the smallholder if it were the means of leading him to realise the advantage of turning his attention more to pig-breeding? Let us proceed to compare the value of the produce of a smallholder's cow with the produce of a sow, in twelve months? A cow will, as a rule, produce in this period one calf which, with twelve months' good feeding, may yield 576 lbs. of meat. On the other hand, what will the sow contribute towards the nation's food supply by producing say sixteen pigs in the year, assuming that they are of an early-maturing variety, and are fed for twelve months? Eight of them would have twelve months' feeding, and eight of them six months' feeding, or an average for the lot of nine month's feeding as against the calf's twelve months. Sixteen pigs at an average of nine months would dress 210 lbs. each, dead weight, or a total of 3360 lbs., all from the produce of one sow, as against 576 lbs. from the produce of the cow in the same period. It must be remembered, further, that three breeding sows can be kept for the cost of one cow. The reproductive capacity of the pig is, of course, immensely greater than that of any other farm animal. Horses will reproduce themselves to the extent of 50 per cent. to 60 per cent. annually, with a maximum not exceeding 100 per cent.; sheep may give 125 per cent., with a maximum not exceeding 200 per cent.; while cattle will reproduce their kind to the extent of 60 per cent. to 75 per cent., annually, the maximum not exceeding 100 per cent. The pig's percentage of reproduction, at two litters in the year, or say sixteen in all, is 1600 per cent., and it may be as high as 2000 per cent. Moreover, the sow can produce her first litter at twelve months' old. There is indeed a good deal of truth in the American saying that the important feature of the pig is its ability to fulfil its purpose here on earth in a hurry and get out of the way. It would not be unfair to assume that it costs twice as much to produce one pound of beef as it does to produce one pound of pork, and that it takes one and a half times as long to produce a pound of mutton as it takes to produce a pound of pork. There may be exceptions to this rule, but on the average these figures would prove correct. Another point in favour of the pig is its ability to consume produce that could be marketed only at a discount.

The advantages of maturing pigs at six months old should not be overlooked. It cuts down necessary housing accommodation, labour and feeding costs, etc., and provides for the producer a quicker return than can be obtained from any other class of farm produce or live-stock reared on the farm. The farmer and the small-holder must be taught what to breed, and have it impressed upon them that it is hopeless to expect success in breeding on haphazard lines. It is essential to know how to feed and treat pigs properly so as to produce healthy good-growing stock, best suited to the requirements of the district concerned, at the lowest possible cost per pound. Pig-breeding, rearing and feeding, wherever convenient and possible, should be carried on as one industry. The ideal system is that the breeder should finish his pigs for the bacon-curer. It may not always be possible for the smallholder to do this. In that case his business should be to breed pigs of the proper class to be finished off by dairy farmers and others with the requisite feeding material available for the purpose. All successful pig-breeders are alive to the importance of fresh air, exercise, grazing, the use of forage crops and by-products of the dairy.

One feels that an important stimulus to the pig industry in Scotland would be the introduction of reasonable transport facilities, and the means of obtaining ample supplies of milling offals of the right sort for the home-feeder. Those who contemplate taking up pig-breeding as an industry, must get rid of the idea that any kind of food or treatment is good enough for the pig. If the industry is to be conducted on proper lines it is essential that there should be an organised system of instruction therefor. Public money has been spent in recent years in training people to take up work on the land, and there is no branch of farming that could be turned to more profitable account by the smallholder than that of pig-breeding and rearing, if pursued intelligently and with reasonably careful attention. If pig-rearing received the attention it deserves production could be increased to a scale that would, to a large extent, meet our evergrowing demand for bacon. It has been estimated that we in this country spend £25,000,000 per annum on bacon. A very large proportion of this is going to other countries, and that is not creditable to our home producers. With a little foresight and intelligent enterprise a large proportion of this bacon could and should be produced at home. We have the people who can do it, but they require to be educated and encouraged to take up the matter in earnest. A primary necessity is a reliable and steady market to which the pig-feeders could send their fat pigs in the full assurance that they would get current value according to weight and quality. This can only be assured by what has already been suggested—the provision of bacon factories on the co-operative principle, such as are to be found on the Continent and in over-seas parts of the British empire. Under some such scheme the feeder would participate in the profits of the trade, and the necessary incentive would be provided by the increased production which is so much desired.

Breeds.—A beginner should carefully consider what breed of pigs will best suit his district and market. In some districts it may be desirable to breed porkers of 80 to 100 lb. dead-weight, to be sold as fresh pork, while in other districts it may be bacon pigs that are most wanted—weighing 160 to 180 lb., well finished with plenty of flesh, fine shoulders, good loins and backs, thick bellies and good hams. There are so many breeds being recommended for the beginner now-a-days that one is apt to get bewildered as to which to prefer. Without being in any sense dogmatic on the point, we should say that a cross between the Middle White and the Berkshire is at anyrate one of the most profitable. Such a cross produces a rapidly-maturing animal, and that is a very important consideration. Some people tell us that the ideal Scottish pig has yet to be evolved, but for the present we must make the best of the breeds we have. They are all right if we breed only the best. We have in Great Britain some of the best pigs in the world, and we should hope that Scotland would have its share. Unfortunately, however, we have some pigs that are most unprofitable either to fatten or to breed from. This is the class that must be replaced by carefully-bred stock which would prove profitable to all that handled them. One encouraging feature of the last few years has been that Scottish firms of live-stock salesmen have been instituting sales of pure-bred pigs, and in the interest of the industry let us hope that such enterprise will be adequately rewarded. Let us suggest, however, that success cannot be expected to attend such sales unless producers consign to them only the best. Breeders should not assume that every one of a litter of ten or a dozen pigs from a pure-bred sow is necessarily of sufficient merit for breeding purposes. These are not the lines on which to build up a herd. Only the very best should be kept for breeding purposes. The others should be put into the fattening pen, and got out of the way as speedily as possible. Another direction in which the success of the pig industry is being handicapped in Scotland is in the policy of fat-stock show societies. Early maturity is not being encouraged as it ought to be. There is a failure to grasp what the trade really demands. The idea seems to be to encourage the exhibition of some sort of unique monster which will attract the curiosity of the public rather than the real utilitarian article. Prizes are offered only for weight, with no consideration of age. The six-months-old pig may have to compete with exhibits three or three and a half years' old. The Highland and Agricultural Society, on the other hand, have been adopting a much broader outlook in regard to pigs. The classification there is such as to offer the greatest possible encouragement to breeders, and the consequent response must be a matter for gratification to the Society.

Open-Air Pig-Rearing.—A good deal has been heard lately about the open-air rearing of pigs. Beginners, however; might be led astray by such indiscriminate advocacy. A system that may be quite possible under certain conditions may be quite unsuitable under others. It is well known that plenty of fresh air is good for all classes of live stock, if adequate provision is made to safeguard the animals against draughts. It is also essential that breeding sows, just as any other animals with young, should have plenty of exercise. But, in the case of feeding pigs, when early maturity and a quick return for the food consumed are the objects aimed at, it is not desirable to keep the animals running out in sunshine and storm, as is sometimes advocated by those who insist that pigs thrive best if allowed to run at freedom in the open. We have lately been told as an instance of the efficacy of open-air pig-keeping that as far back as 1814 large herds of swine were kept and reared in the Highland glens. The authority for this statement says they were small, with long bristles on their backs, and when one year old were sold at four to six shillings each. But do we really wish to go back to those methods of what are called "the good old times?" We think not. We must advance with the times; and there has been a great advance in the pig since the days referred to, largely owing to improved methods of treatment. The writer's idea in feeding pigs is to have them comfortably housed, kept clean and fed with strict regularity. Following such methods there will be a much quicker return for the outlay than by allowing the animals to run out in the open. They should be given a run out in the open for an hour or so daily, but then they should be put back to the house, given plenty to eat of the right class of food and a dry bed, and they will rest contentedly for the remainder of the day. Under such conditions they will put on flesh quicker than any other class of farm live stock.

Breeding and Showing.—We have in Scotland many pedigree herds of different breeds of pigs, and this is essential to the success of the feeding industry, as the feeder can procure different breeds if he desires to go in for first crosses. But should a beginner decide to go in for a pure-bred herd he will require to wait a little longer for his return. A pure-bred herd demands more skill and care than are necessary in the case of a feeding herd. The breeder who expects to be successful must have a thorough liking for, and a good knowledge of the breed he goes in for, and he must personally supervise and attend to all details. He must have his own ideal of the class of stock he would like to produce. He should personally select a few sows which conform to his ideal, and ask for no one's advice, for if he requires advice he had better leave the adventure alone. The breeding sows should be of good depth with plenty of vitality, and inclined to take plenty of exercise. He must also select his stock boar as near to his ideal as he can find. It should not only be an animal of good individual merit, but should be bred from the best of stock on both sides of his pedigree. To start with, the owner of a pure-bred herd may find that he has to discard a good many of both sexes from a litter as they may not come up to his ideal, but if he is proceeding on correct lines he will find that he will have fewer to discard as time passes. If he has the opposite experience—if he finds that he has more and more to discard as time goes on—then he will realise that he is not on the proper road to success. In the case of a breeding herd it is very desirable—almost essential—to show, in order to keep the herd before the public. It is, indeed, a duty in the interests of the breeder, and the particular breed in which he is interested.

Showing pigs is an art, and success depends largely upon the herdsman or those in charge, more so, perhaps, in the case of pigs than in that of any other class of stock. They are not easily handled until they have confidence in their attendant; and in training for the show-ring firmness and gentleness have to be practised. With the pig, style and gaiety count for much, and with head erect it shows up to advantage.

STANDARDISATION OF RENNET EXTRACTS.

RENWICK HUTSON LEITCH, M.A., B.Sc., B.Sc. (Agric.), N.D.A. (Hons.), N.D.D.

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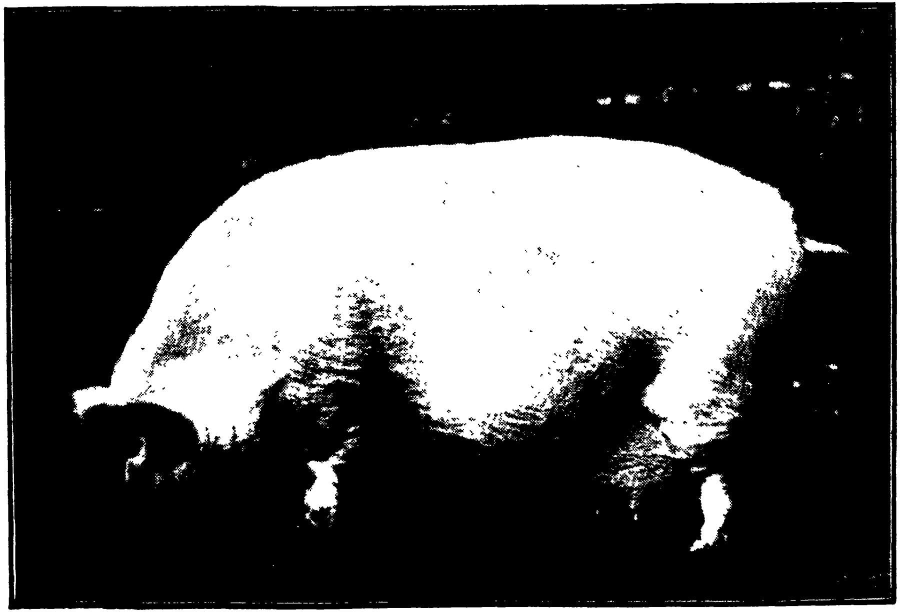
A STANDARD test for estimating the strength of rennet preparations has long been sought for, both by manufacturers and by importers of rennet. It has been the desideratum of the large consumer (the cheese factory manager), the pharmacist and the biologist. The manufacturer has a special interest in such a test. Owing to the varying quality of the vells from which the rennet is extracted, the duration of the extraction process is very irregular, so that there can be no fixed time for decanting the rennet. The "strength" may come up in less than a week; frequently, however, it may not emerge for a fortnight or three weeks. It is important for the manufacturer to know when the extract is sufficiently strong; if he decants the rennet too early, it will be too weak for industrial requirements, and it is a troublesome matter to fortify a weak rennet. On the other hand if a long steep is required to ensure the necessary degree of strength, the rennet will be rich in undesirable bacteria, yeasts and, occasionally, mould spores; it may ferment and acquire a bad smell. A standard test is therefore required to guide the manufacturer at this stage in the technical process.

Again, the finished rennet gradually loses strength; some extracts lose strength much more quickly than others (owing it may be to bacterial action or to the incidence of oxidases). Bulked rennet should be tested from time to time throughout the season and if weak, refortified.

From the cheese maker's point of view, a standardised test for rennet is most desirable. In order to ascertain when the rennet should be added to the ripened cheese-milk, the maker employs the "rennet test." Such a test consists in estimating the number of seconds which one drachm of rennet takes to coagulate 4 ounces of the cheese-milk at a temperature of 86° F. (Normally this is



MIDDLE WHITE SOW.

"Highland and Agricultural Society's Show," Stirling, 1921.

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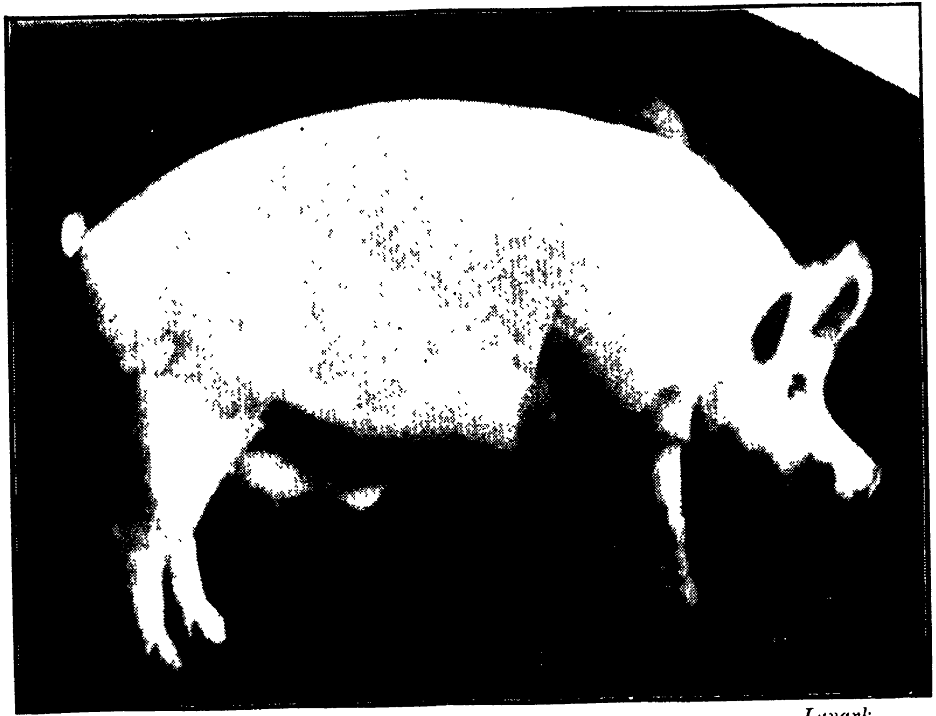
LARGE WHITE SOW.
Champion "Royal Agricultural Society's Show," Derby, 1921.

E. W. Tattersall, *Brodick.*

LARGE BLACK SOW.

Champion "Highland and Agricultural Society's Show," Stirling, 1921.



Brown, *Lanark.*

LARGE WHITE BOAR.

Champion "Highland and Agricultural Society's Show," Aberdeen, 1920.

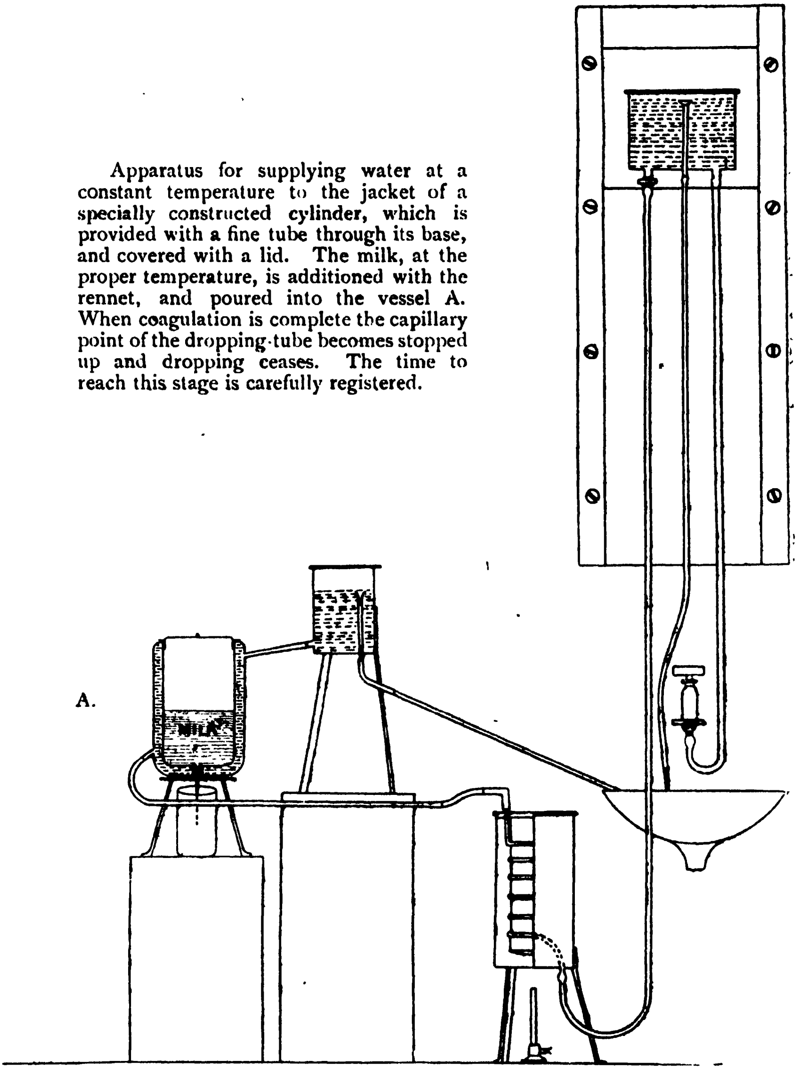
about twenty seconds). Now this period of coagulation is conditioned by two factors (1) the strength of the rennet, and (2) the acidity of the milk. As the rennet test is merely an indirect method of measuring the acidity of the milk, it is essential for the accuracy of the test that the rennet be standardised. If both the rennet and the milk be variables then the test is valueless. If a weak rennet be employed, coagulation in twenty seconds will mean that the milk is too acid when the rennet is added and the quality of the cheese will consequently suffer.

In determining the strength of rennet extracts, Soxhlet's method as modified by Fleischmann has hitherto been adopted. The process consists in estimating how many cubic centimetres of milk of ascertained acidity are coagulated in forty minutes at a temperature of 35° C. by 1 c.c. of liquid rennet or 1 gr. of rennet powder.

The procedure is as follows:—

"Five c.c. of the rennet solution are made up to 100 c.c. with distilled water, and well mixed. Ten c.c. of this dilution are blown forcibly from a pipette into 500 c.c. normal fresh milk, at a temperature of 35° C. and the exact time to a second noted when the two liquids are brought together. The length of time which elapses before coagulation is apparent is noted. The strength of the rennet solution is then calculated according to the formula $x = \frac{40p}{t}$, where x = the quantity of milk which would be curdled in forty minutes at the same temperature by a similar quantity of rennet, p = the proportion between the rennet and the milk, and t = the time in minutes. For good results p should be 1000 (or multiple of it), and t, between two and five minutes." [Fleischmann *Lehrbuch der Milchwirtschaft.*] To maintain an even temperature during the period of coagulation is a difficult matter. In standardising rennets, when considerable accuracy is demanded, a special apparatus, such as that elaborated by the author should be used. Water at a constant temperature (95° F.) is supplied from Pulfrich's circulator (see *Zeitschrift für Instrumentenkunde*, Jan. 1898) to the jacket of a specially constructed glass cylinder, through the base of which passes a glass tube drawn to a fine point. The cylinder is provided with a lid. One litre of milk at 95° F. has added to it 10 c.c. of a 10 per cent. dilution of the rennet to be tested, and is immediately poured into the glass cylinder. The milk will run out in a fine stream through the glass tube. When clotting takes place, the capillary point of the dropping-tube becomes stopped up, and dropping ceases. The time from the addition of the rennet until coagulation (as determined in this way) is apparent, is carefully registered by a stop-watch. The fineness of the bore of the dropping tube is of importance; it should be about 0·5 mm. in diameter and deliver 100 c.c. in three minutes. Even then the bore does not become stopped up until thirty seconds after coagulation is evident on the finger or on the bulb of the thermometer.

The great drawback to this test is the difficulty of securing milk which will give a uniform test from day to day. Even when care is taken to have the milk at the same acidity and temperature each day, considerable variation will be found in the time of coagulation for the same rennet. This is due partly to small variations in the ash constituents, partly to variation in the hydrogen ion concentration, but mainly to the biochemical condition of the milk. It is a well established fact that, for several hours after it has been produced, fresh milk has an anti-rennin action, the intensity of which varies from day to day. This reaction gradually weakens and disappears when normal milk is used, so that, by



Apparatus for supplying water at a constant temperature to the jacket of a specially constructed cylinder, which is provided with a fine tube through its base, and covered with a lid. The milk, at the proper temperature, is additioned with the rennet, and poured into the vessel A. When coagulation is complete the capillary point of the dropping-tube becomes stopped up and dropping ceases. The time to reach this stage is carefully registered.

the fifth hour, its effect is small and almost negligible as the following test shows:—

3rd November 1919.

Time of Test.	Acidity.	Time of Coagulation.	
	Per cent.	Min.	Sec.
10.30 a.m.	·154	5	10
11.30 „	·152	5	20
12.30 p.m.	·158	5	25
2.15 „	·163	5	10
4.15 „	·165	4	55

Sometimes, however, it persists considerably longer, especially in milk of cows with udder infections. Autumn and winter milk has a similar reaction. In a series of over fifty tests with fresh separated milk carried out during September, October and November of 1919, we have found that this restraining action frequently persisted from twelve to twenty-four hours. As an example the following may be quoted,

14th October 1919.

Time of Test.	Acidity.	Time of Coagulation.	
	Per cent.	Min.	Sec.
9 a.m.	·178	3	30
10.15 „	·167	4	0
11.15 „	·167	4	0
1.15 p.m.	·167	3	50
3.45 „	·167	4	20

15th October 1919 (Same Milk).

Time of Test.	Acidity.	Time of Coagulation.	
	Per cent.	Min.	Sec.
9.15 a.m.	·168	3	25

In contradistinction to this a test of milk from the same herd in which no apparent restraining action has been developed is appended.

21st October 1919.

Time of Test.	Acidity.	Time of Coagulation.	
	Per cent.	Min.	Sec.
10.30 a.m.	·167	3	50
11.30 „	·167	3	43
12.30 p.m.	·171	3	10
2.30 „	·179	3	0
3.30 „	·181	2	40
4.30 „	·182	2	30

If, then, perfectly fresh new milk is used, a uniform test cannot be got, and the statement that a commercial rennet has a strength of 1 in 18,000 or 1 in 12,000, etc., is meaningless. Such a statement carries with it no guarantee whatever.

What is required is a standard milk. To procure this, a modification of Vandervelde's method (*Biochem. Zeit.* 3, 315) may be resorted to. This consists in testing fresh separated milk of the same origin for several days in succession. The cows producing the milk must be normal, and, above all, have sound udders. When the same "rennet test," with a control rennet (such as Hansen's Standard) has been got for two or three days in succession, the milk at 20° acid is preserved with an iodoform-ketone solution (made by dissolving 3 per cent. by volume iodoform in acetone, and using 3·3 c.c. for every 25 c.c. milk). This preserves the milk from bacterial fermentation, and at the same time has no effect on the rennin enzyme. Milk prepared in this way can be kept for several weeks without change.

This method while it is an improvement on the former is still open to error because it is seldom that two samples of fresh normal milk from different sources with an initial acidity of ·2 per cent. will show the same rennet test. If this method were adopted in two different laboratories which draw their milk supplies from different districts the same rennet would exhibit different apparent degrees of strength.

Much better results may be got by using reconstituted milk from milk powder, the reaction of which has been adjusted by the addition of calcium chloride. This method has been employed in our laboratory for the past four years during which time several hundreds of tests on the strength of rennet extracts have been carried out.

Separated milk powder is used; that prepared by the spraying (Merrell-Soule) process alone is of service. Desiccated milk made by the Hatmaker or Just process is not well adapted for the purpose. The milk from which the powder is prepared should be produced on permanent pastures preferably during the months of June and July, and be the product of healthy herds. The milk should be perfectly sweet and fresh when the desiccating process begins, and no chemicals should be added to the milk before drying.

The milk powder is reconstituted with water in the proportion of nine parts of water to one part of milk. The milk powder, having been carefully weighed out, is stirred up with half the quantity of water, and after the lumps have broken down, the rest of the water is added. The reconstituted milk is immediately pasteurised to 160° F., held at this temperature for fifteen minutes, and then cooled down to the vicinity of the testing temperature, *i.e.* from 90° to 95° F. Pasteurisation of the reconstituted milk to this temperature has been found to be necessary to secure greater uniformity of results.

In the absence of an activator, reconstituted milk, whether pasteurised or not, has slow coagulating properties; the slight alteration in the physico-chemical condition of the milk solids brought about by the nature of the desiccating process has profoundly affected the bio-chemical reaction of the milk, and especially its behaviour to rennet. The period of coagulation is substantially increased, and the coagulation point is more difficult to determine than in the case of normal milk, *e.g.*

	Milk.	*Rennet.*	*Time of Coag.*
Aug. 22, 1921.	Separated Milk (500 cc.).	5 cc. 10% Rennet dilution.	3 min. 5 sec.
	Reconstituted Milk (500 cc.).	" " "	4 min. 55 sec.

Among the agents which may be used to restore the normal rennet reaction to reconstituted milk are calcium chloride, calcium phosphate, lactic acid, hydrochloric acid and citric acid. Of these, calcium chloride is the most useful in practice; 2·5 c.c. of a 20 per cent. solution of the pure salt added to 1000 c.c. of the reconstituted milk will give a representative rennet test. The quantity of $CaCl_2$ required for a selected milk powder was determined as follows. The average period of coagulation of a large number of samples of fresh separated milk was ascertained, Soxhlet's method and standards being employed. The tests were carried out during the months of June and July; mixed milk of different herds was employed, and the milk was about five hours' old when tested. Duplicate tests were made on each sample. The exact amount of calcium chloride (20 per cent. solution) to be added to the reconstituted milk, so as to give the same rennet reaction was thus ascertained.

The calcium chloride solution may be added to the water of reconstitution or to the milk just before the test is made. In the former case the calcified milk should be allowed to stand for about an hour before being tested; in the latter case the temperature of the milk is adjusted to 95° F., and the calcium chloride then added.

In the actual conduct of the test we have adopted as our standard, 500 c.c. reconstituted milk (pasteurised as described), 1·25 c.c. 20 per cent. calcium chloride solution. and 1 c.c. *undiluted* rennet. The use of undiluted rennet simplifies the test, and does away with any variation caused by dilution. The calcified milk adjusted to the necessary temperature is added to the rennet contained in the testing cylinder (beaker or enamelled jug), thereby securing a rapid and very thorough mixing of the milk and rennet extract. By this method a strong commercial rennet such as Hansen's Standard will have a period of coagulation of approximately one and a quarter minutes.

When smaller quantities of milk are employed, it is necessary to dilute the rennet; with 250 c.c. milk, 2·5 c.c. of a 10 per cent. rennet dilution, and with 100 c.c. milk, 5 c.c. of a 5 per cent. rennet dilution should be used. The dilutions must be very carefully made if error is to be avoided. The use of carefully graduated pipettes and measuring vessels, thorough mixing of the rennet extract and the water of dilution, the rinsing of the measuring pipette into the thinned rennet, and the absence of foam from the rennet dilution are important details. The diluted rennet is blown into the milk from the pipette.

When 100 c.c. milk are used for making the test, all the measurements should be made with as high a degree of accuracy as possible. If a large number of tests have to be made at one time, the use of 100 c.c. milk will be found a great convenience as regards economy of both material and time, but reliable results will be got only by a careful and experienced worker.

It is important that the temperature throughout the test be maintained at 95° F., and that the exact point of coagulation be observed and recorded (a stop watch being used). The coagulation point is not so sharply defined as in the case of raw milk. Reconstituted milk has a small degree of flakiness; minute flocculent particles are distributed throughout its mass, the appearance of which might be mistaken for incipient coagulation by the inexperienced. Coagulation, however, is quite distinct from this.

A blue glass spatula or the cylindrical bulb of a mercury thermometer shows up coagulation most plainly. Warning is given of the approaching coagulation point by the mercury surface becoming dull. Only a few seconds elapse between the dulling and the coagulation point in the case of a strong rennet, but with a slow or weak extract the difference may be nearly two minutes.

Lactic acid, hydrochloric acid, and citric acid have proved less satisfactory as activators owing to the deep-seated changes they bring about in the reconstituted milk. When these acids are added to the water of reconstitution in amounts which would be sufficient to activate the milk, some of the casein is coagulated; this change is more pronounced if the milk be pasteurised. When acids are used as activators it is difficult to get uniformity from day to day.

Calcium phosphate has given results almost comparable with calcium chloride, but it is less convenient to use.

Lime water in feeble doses accelerates coagulation, but never to the same extent as calcium chloride; as soon as sufficient is added to neutralise the natural acidity of the milk, rennet action is arrested,

It should be observed that all milk powders may not give the same rennet test with a similar addition of calcium chloride, but if obtained in bulk, such as in 10 lb. tins each lot can be standardised by varying the amount of calcium chloride so as to give a test corresponding to that obtained with the previous sample. It is also better to standardise against a sample of strong rennet whose strength has recently been determined by the previous sample of standardised milk powder.

Milk powder made from milk produced early or late in the season may require from 3 to 5 c.c. of 20 per cent. calcium chloride solution per 1000 c.c. reconstituted milk instead of 2·5 c.c. But once the quantity of $CaCl_2$ to be added has been determined, it should not be varied with the same sample of milk powder.

The same principle may be adopted with fresh unpasteurised separated milk, the coagulating powers of which are subject to considerable daily variation. In this case reference must be made to a standardised milk powder or to a standardised rennet for comparison. Winter milk frequently requires the addition per 1000 c.c. of 2·5 c.c. of the calcium chloride solution to give it a coagulating power equal to that possessed by summer milk.

One occasionally finds that successive rennet tests made with the same rennet dilution exhibit considerable differences in the period of coagulation, especially if an interval of one hour or more elapses between the tests. This variation is particularly marked in the case of turbid commercial rennets. Rennet dilutions for testing should therefore be freshly made up on each occasion and be tested within ten minutes. A fresh dilution should be made up if the same rennet has to be tested again at an interval of more than half an hour. It is no advantage to make up the dilution in a 14 per cent. salt solution instead of in water. Muddy rennets should be well mixed before testing.

It is not claimed that the foregoing test in its present stage of development will ensure under all circumstances absolute uniformity of results, because a bulk sample of milk powder may not be always homogeneous throughout. But the results which this test gives are subject to comparatively little variation, and the error is never large as with Soxhlet's method. It might be better to bring all samples of milk to the same absolute hydrogen ion concentration before the addition of the $CaCl_2$. This point is now being investigated.

THE DEER FORESTS COMMITTEE.

In November 1919 the Secretary for Scotland appointed two Departmental Committees to deal respectively with game damage and heather-burning and with deer forests. The former Committee reported in July 1921, and its Report formed the subject of an article in the issue of this *Journal* for October of that year. The Report of the latter Committee has now been issued as a Parliamentary Paper (Cmd. 1636), to be obtained from H.M. Stationery Office, price 3s. or by post 3s. 2d.

The Committee consisted of Sir John Stirling Maxwell, Bart., LL.D., Chairman, Colonel Donald Cameron of Lochiel, C.M.G., and Messrs W. J. Dudgeon, A. Edward, Peter M'Intyre, Donald Mackay and Christopher Maclennan, and their remit was as follows:—

To enquire and report with regard to lands used as deer forests:—

(*a*) Whether any of these lands (not being lands already reported on by the Royal Commission (Highlands and Islands) 1892), and, if so, which, are capable of yielding a reasonable return if put to agricultural or other productive uses, and, if so, to what uses;

(*b*) How far the productive use of these lands is compatible with their continued use for any, and, if so, for what, sporting or recreative purposes ;

(*c*) How far the conversion of these lands to productive uses is likely to affect local public revenue.

The Committee circulated during the summer of 1920 a questionnaire, the replies to which have enabled them to present fuller and more accurate statistics regarding deer forests than have been obtained on any previous occasion (given in Appendix IX.). They inspected fifty-six forests, and took evidence or received statements from 237 witnesses, including representatives of many public bodies. Owing to the need for economy, they were unable to carry out completely the enquiries that were involved in their original remit, and they recommend that any further enquiry that may be required should be carried out locally. The subject of the Committee's remit is, like the questions dealt with by the Game and Heather-Burning Committee, a highly controversial one which has been prominent in the local and national politics of Scotland for at least forty years. The Committee have, however, presented a unanimous Report, and their conclusions and recommendations, based as they are on wide enquiry and impartial consideration, will command respect in all quarters.

Growth of Deer Forests.—The Report opens with a historical account of the origin and growth of deer forests. Their growth is inseparably connected with the change that was brought about in the Highlands in the latter part of the eighteenth century by the introduction of sheep-farming on a large scale, which "rendered the economic future of the Highlands almost entirely dependent on the price of sheep." The area occupied by the new sheep farms was made available partly by the "clearances" that have left so bitter a memory in the Highlands, and partly by the conversion of old deer forests into sheep ground. The Committee state that the area devoted exclusively or mainly to deer reached its lowest point between 1780 and 1790, and that the number of red deer in Scotland was probably smaller at that time than at any other within the limits of history. Before, however, the conversion of forests into sheep farms was complete, a reaction had set in. Deer-stalking and other forms of Highland sport became increasingly attractive to wealthy Englishmen, and by the sixties the letting of Highland shootings had become general. The value of wool began to decline in the seventies and that of sheep in the eighties. The course of prices is shown by diagrams in Appendix IV. to the Report. Highland grazings were specially affected by the growing distaste for the three-year-old wether mutton that was their staple produce. It became difficult in the eighties to find tenants for high grazings where sheep could not be wintered.

Attention was called by the Napier Commission in 1884 to the increase in the area under deer forests and to the damage done by deer to crops and grass. A return of deer forests was made in 1891, which gave the total area as nearly 2½ million acres; this figure the Committee believe to have been an understatement. The Royal Commission of 1892, which reported in 1895, found that some 320,000 acres then under deer forests might be used for the

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formation of new crofters' holdings or the extension of existing holdings.[1] Both of these Commissions recommended that a check should be placed on the extension of the deer forest area. No action, however, was taken, and the formation of new forests went on with increased activity, as the prices of sheep and wool continued to decline. In 1912 there were over 200 forests, the total area of which was nearly 3,600,000 acres, or 19 per cent. of the whole area of the country. This increase was not brought about solely by economic pressure. The additional area afforested during these twenty years, amounting to over 1,100,000 acres, was naturally of a better class than the older forests, and the Committee are satisfied that, even at the prices then current, a considerable part of this area could have been farmed at a profit, after paying a moderate rent.

At this point the Committee give a calculation of the net diminution of production due to the existence of deer forests in 1912, which they find to have amounted to only $\frac{1}{16}$ per cent. of the national consumption of meat, and $\frac{1}{8}$ per cent. of the national consumption of wool. On the other hand, while the deer forests served a useful local purpose during the period of low prices, the Committee consider that the total withdrawal of so large an area from pastoral uses was, from the national point of view, very much to be regretted. Its devotion to sport without restriction caused widespread dissatisfaction.

Effects of the War.—Whatever might have been the case if the war had not occurred, the Committee are of opinion that there are too many deer forests and deer in Scotland for the present or the prospective demand. The formation of "exclusive" deer forests has been overdone.

During the war many forests were unlet, and others were let at very low rents. The killing of deer and the distribution of venison was organised by the Venison Supply Committee, set up in 1916. From the point of view of the Deer Forests Committee, however, the most important effect of the war was the introduction of stocks of sheep and cattle into forests and the increase of existing stocks, mainly under voluntary arrangements, but in some cases under compulsory orders. About 100 forests were affected by these schemes; the stocks of cattle reached a maximum of 8000 in 1918 and those of sheep a maximum of 107,000 in 1920.

Since 1912 the deer forest area has been reduced by 150,000 acres. No new forests have been formed, while eleven have been or are being wholly restored to pastoral use, and three have been acquired in whole or in part by the Forestry Commission. The number of existing forests is 189.

The Committee go on to point out that in many of the older and larger forests there has always been a considerable stock of both sheep and cattle, *e.g.*, those on the Atholl, Lochiel and Lovat estates. "The idea," they say, "that a deer forest must be entirely sacred to deer, appears to be quite modern, and based to a large extent on ignorance of the habits of deer and confusion between the art of creating and the art of maintaining a forest." Particulars are given of the recent successful stocking of the Kintail, Langwell and Strathconan forests. In all these cases the proprietors take as much interest in farming as they do in deer stalking.

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[1] It has frequently been stated, in error, that the whole area of 1,782,785 acres scheduled by the Commission was under deer forests.

Classification of Deer Forests.—A valuable portion of the Report is the classification of deer forests from the point of view of pastoral value. Class I. consists of deer forests fit for no other purpose and Class II. of forests capable of carrying only a light summer stock, the conversion of which into sheep runs "would entail a serious loss to the Valuation Roll as well as to their owners;" Class III., which includes the largest proportion of the total forest area, consists generally of high summer grazings, the capacity of which for carrying a permanent stock is limited by deficiency of wintering ground; while Class IV. comprises the forests that are capable of bearing a full permanent stock of sheep or cattle. This type is mainly found among the recent additions to the forest area.

The Committee's recommendations are governed by four fundamental factors:—(1) the future movement of the prices of sheep, wool and timber; (2) the possibility of obtaining sufficient wintering for increased hill flocks; (3) the deterioration of hill grazings; (4) the cost of housing and equipment. "The part these factors are destined to play is unfortunately," they say, "still a matter of speculation."

Recommendations.—The Committee see no reason why forests comprised in Class I. should be diverted from their present purpose. Subject, however, to the uncertainty attaching to the factors mentioned above, they make the following recommendations with regard to the three other classes. While sport should continue to be the primary use of forests of the second class, a light summer stock of sheep or cattle should be introduced where this can be done at a profit, that is, where the rent apportioned for the grazing makes good any reduction in the total assessed rent of the forest. The forests comprised in Class III. afford, in the Committee's opinion, an opportunity for a compromise between deer and sheep or cattle, by the reintroduction of a limited permanent stock, to be determined by the extent of the wintering ground. Wherever a small nucleus exists, the tendency will always be to increase it when prices are favourable. More drastic treatment is recommended for Class IV. These forests should be restored to pastoral uses, except where the land has proved unhealthy for sheep when bearing a reasonable stock under competent management, or where it proves impossible to obtain a satisfactory tenant at an economic rent. No compensation should be paid for any loss incurred by the proprietor, but the capital risk may be reduced by allowing a period of say five years for conversion.

Proposed Local Committees.—As has already been stated, the Committee were unable fully to carry out their remit by classifying existing deer forests on these lines. They recommend that Local Committees should be set up for this purpose. Had Part I. of the Agriculture Act, 1920, remained in force, deer forests, so far as they contain "grass land," would have come within the scope of the powers conferred upon the Board of Agriculture for Scotland for the control of cultivation. Now, however, legislation would be required to confer the necessary powers upon the proposed Committees. The suggestion is, that a Committee, consisting of two deer-forest owners, or their nominees, and two practical farmers, with a neutral chairman appointed by the Lord President of the Court of Session, shall be appointed for each of the following areas:—(1) Caithness and Sutherland, (2) Ross and Cromarty, (3) Inverness-shire, (4) Argyll and Dumbartonshire, (5) Aberdeenshire, Banffshire and Kincardineshire, (6) Perthshire and Forfarshire, with the duty of classifying existing deer forests and determining the stock each should carry.

The Committee make the further important recommendation that the extension of deer forests should be forbidden by statute, except with special sanction from the Secretary for Scotland, given after enquiry. Legislation for this purpose would involve the definition of the term "deer forest," a matter that has given the Committee some trouble. The definition they have adopted is "an area from which the stock of sheep or cattle has been wholly or partially removed in the interests of deer-stalking, or which is derelict for want of a pastoral tenant, and used for this purpose." They also recommend that an annual return should be required to be made to the Board of Agriculture for Scotland of the stock of sheep and cattle in each deer forest.

These are the Committee's recommendations under the first two heads of their remit. Before passing to the third head, we may mention certain subsidiary matters that they discuss, some of which also came under review by the Game and Heather-Burning Committee.

Other Matters.—(1) One of these is the anomalous state of the law regarding march fences. It is generally taken to be the law that the owner of a deer forest can compel his sheep-farming neighbour to contribute to the cost of erecting a march fence to exclude sheep from the forest, while the owner of the sheep farm has no corresponding right to compel the deer forest owner to contribute to the erection of a march fence to exclude deer from the sheep farm. While, however, the Committee consider that the whole cost of erecting and maintaining march fences between grazing land and land principally occupied as a deer forest should be borne by the deer-forest proprietor, and that such fences should be proof against deer as well as sheep, the complete enclosure of deer forests by deer fences does not appear to be practicable. Nor do they regard it as certain that such fences are desirable, since the give-and-take between the forests and the sheep ground is often the most advantageous arrangement for both. It may be recalled that the Game and Heather-Burning Committee recommended that as soon as economic conditions permit, it should be compulsory for owners of deer forests to fence their forests efficiently where they adjoin cultivated or grazing land.

(2) Where sheep stray on a neighbouring forest, the periodical gatherings sometimes give rise to friction between farmers and shooting tenants. The Committee recommend that statutory

dates should be fixed for the gatherings as follows :—(1) in June, (2) before 15th August, (3) between 20th and 30th September, (4) in November, in each case after due notice.

(3) The Committee also draw attention to the short-sighted policy that has led to the neglect or even to the destruction of the natural stock of grouse in certain forests. The demand for grouse moors has of recent years exceeded the demand for forests, and proprietors are beginning to realise that a good grouse moor with a light stock of sheep and the chance of a stag is a better asset than a mere deer forest.

(4) The recent increase in the number of foxes, hooded crows and other species of vermin that frequent deer forests has in some cases been due to tenants of forests encouraging foxes for the purpose of keeping down grouse. The Committee agree with the Game and Heather-Burning Committee that special powers should be provided for the protection of sheep stocks against these pests, and that the use of poison for killing them should, under proper precautions, be legalised.

(5) The Committee were impressed by the large extent of old heather that needs burning in the various deer forests they visited. Nearly 1,400,000 acres of the total forest area lie above the 1500 feet line, and late snow makes burning impossible within the present time limit. The Committee recommend that in forests where grouse are negligible, the Sheriff should be empowered to sanction the burning of heather up to 15th May. This suggestion was communicated to the Game and Heather-Burning Committee, with 31st May as the date, but that Committee did not concur in it. It may be remarked that the mention of the Sheriff appears to imply that the Sheriff has an executive function under the existing law, which is not the case.

(6) While the Committees did not visit a sufficient number of deer forests to justify them in generalising on the scope deer forests afford for small holdings, they found that some forests on the lower levels might prove capable of settlement, while, in regard to forests coming within Classes II., III. and IV., the same opportunity might be given for their use by any adjoining smallholders owning or acquiring a club stock, as in the case of the sheep farmer or individual grazier. In this connection they comment favourably on the scheme that has been carried out for the partial stocking of Kintail Forest by the co-operation of the proprietor and the Board of Agriculture.

(7) Finally, many of the deer forests, especially on the west coast, contain planting land of the first quality, and under the scheme drawn up by the Forestry Commissioners, which has now been suspended in the interest of national economy, it was proposed to acquire and afforest large areas.

Rating.—Under the third head of their remit, the Committee were directed to inquire how far the conversion of these lands to productive uses was likely to affect local public revenue. More recently a Committee has been appointed, under the chairmanship of Lord Dunedin, to consider the whole question of local rating in Scotland.

The Deer Forests Committee found, from the answers to their questionnaire, that the total assessed rental of the 189 existing deer forests amounted in the year 1914-15 to £171,000 and in the year 1920-21 to £119,000, showing a decrease of £52,000, or 30 per cent. These figures could not be checked from the Valuation Roll, which does not distinguish between deer forests and other shootings.

The only counties in which deer forests and shootings contribute a considerable proportion of the total valuation are Inverness and Ross and Cromarty. In the former the pre-war proportion was 32 per cent., while the present proportion is 25 per cent.; in the latter the figures are 21 per cent. and 15 per cent. respectively. Particulars are given (in Appendix VIII.), for each parish in these counties which show that, before the war, in twelve parishes in Inverness-shire and ten in Ross and Cromarty the deer-forest and shooting rents formed more than one-third of the total valuation, the maximum figures being 78 per cent. in Glenshiel, 70 per cent. in Alvie, 69 per cent. in Kintail, and 67 per cent. in Moy and Laggan.

After pointing out the distinction between the gross rent paid by shooting tenants and the net rent entered in the Valuation Roll, the Committee go on to compare the actual forest rents with possible grazing rents, so far as the data are available. But they find it impossible to arrive at "crisp conclusions," on this part o their remit, while the relative values of deer forests and sheep farms as revenue-producing subjects are so uncertain and liable to change. Their view generally is that in deer forests placed in Classes I., II. and III. the effort to increase production should not be pushed beyond the point where it will begin to affect local revenue. In this connection, however, they again emphasise the point already made, that deer forests without a fair bag of grouse are an uncertain source of revenue alike to their owners and to the public authorities. In August 1921 there were no fewer than thirty forests, excluding the smaller forests, unlet, and a firm of sporting agents stated that for every enquiry for deer forests they had ten for grouse moors, whereas the number of grouse moors on their list was less than double the number of forests.

The Committee regard it as anomalous that Income Tax should, in the case of deer forests, be paid on the sporting as well as on the grazing value, and they support the suggestion of the Income Tax Commission that these values should be separated. If Income Tax were confined to the grazing value, there would be an increase in the net return to the owner, and the assessable rental would be correspondingly increased.

Finally, the Committee reject the suggestion that any diminution in local revenue caused by the restoration of deer forests to pastoral uses should be compensated out of the Exchequer. Where it is decided, after due consideration, that it is in the public interest to discontinue any deer forest, they think that the loss to the owners and to the ratepayers should be frankly faced.

The Committee's general conclusions are conveniently summarised on pp. 27-8 of the report, and their recommendations on

p. 32. A number of useful Appendices follow, the first three of which give a list of the 237 witnesses, a copy of the questionnaire issued to owners of deer forests, and lists of forests mentioned in the *Old Statistical Account* (1791-1799), and in Scrope's *Art of Deer-Stalking* (1838). Appendix IV. consists of the diagrams already mentioned, showing the course of the prices of Blackface and Cheviot sheep and wool from 1820 to 1920. Appendix V. gives in elaborate detail the estimated production of forests under deer at various dates, as compared with their production had they been under sheep. Appendix VI. gives a calculation showing that for each seven-year-old stag a total stock of twenty-four head of deer must be maintained. Appendix VII., contributed by Mr John D. Sutherland, Assistant Commissioner for Scotland, Forestry Commission, gives particulars of the planting work being carried out by the Commission, with estimates of the ultimate produce. Appendix VIII. gives the valuation figures for each parish in the counties of Inverness and Ross and Cromarty, already mentioned. Appendix IX., extending to twenty-two pages, gives a complete list of the existing deer forests, with the total estimated extent, the areas below 1000 feet, between 1000 and 1500 feet and above 1500 feet, the number of sheep and cattle grazed in 1921, and the assessed rent for the year 1920-21. This is, as has already been said, the most complete and accurate return that has ever been made. Finally, a list is given of the forests that have been restored to pastoral uses or acquired by the Forestry Commission.

TESTING OF NEW VARIETIES OF THE POTATO FOR IMMUNITY FROM WART DISEASE.

As part of their programme for encouraging breeders to produce new improved varieties of the potato, the Board established at Philpstoun in 1919 a station for conducting trials of new varieties for immunity from wart disease. It is proposed to give a short account of these trials which have now been held in three successive seasons.

So far the only known method of combatting this pernicious disease is to grow varieties which have been proved to be immune from its effects. No means of eradicating it has yet been discovered. The cause of this immunity of certain varieties of potatoes is unknown. It is certain, however, that so far as authentic records go, no case has been recorded of an immune variety yielding to the ravages of wart disease.

Samples of new varieties of potatoes are tested for at least two seasons, and if they satisfactorily pass the trials a certificate of immunity from wart disease is granted. A single year's test cannot be regarded as conclusive, especially in the case of early varieties, since in a dry season which is unfavourable to the development of the disease, a susceptible variety might conceivably emerge scathless from the test; only such varieties as have been proved to be free from the disease in the first year's test are retained for a second year.

In planting the sample seed tubers every care is taken to ensure that each variety is subjected to the attack of the disease organism, direct infection of the soil in proximity to the seed being made at the time of planting.

Arrangement of Samples for Tests.—Samples of varieties to be included in the tests are first sprouted in boxes. At this stage the colour of the sprout of the sample is noted, and tubers which have sprouts differing in colour from the bulk of the sample are removed. During the growing season, observations are made on the characteristics of the varieties under test, and all plants which are obviously not true to type in any sample are noted. Observations are also taken on the occurrence of other diseases than wart disease, notably blight, corky scab, mosaic and leaf-roll.

In the first year of trial, the varieties are arranged in plots so that all those from one sender are together, but in the second year the varieties are classified according to the following characteristics and arranged in the field test accordingly:—

(1) Time of maturity;
(2) Colour of sprouts;
(3) Colour of skin of tuber;
(4) Shape of tuber;
(5) Colour of flesh of tuber;
(6) Colour of flower;
(7) Characteristics of haulm.

This arrangement ensures that similar varieties are placed together, and at the same time facilitates demonstration and comparison. This plan of arrangement of varieties is really a system of classification, a system which appears to be as comprehensible and, at the same time, as practical as any classification of the varieties of the potato yet published. Its basis is the colour of the sprouts when the tubers are sprouted in diffuse light. This characteristic has so far proved to be entirely stable, and it is one which it is very easy to recognise and describe. Details of the method of sprouting are given in the Board's leaflet, No. 43, "Seed Potatoes."

The primary classification of the varieties is made according to dates of maturity, because this characteristic is also relatively constant under given conditions. It is also a characteristic which is of the greatest value to the potato grower, and its appearance in a system of classification is bound, therefore, to make it very attractive to the practical man. The trials to determine the date of maturity are conducted simultaneously at Philpstoun and at the Board's Plant Registration Station at East Craigs.

The date of maturity and the colour of the sprouts constitute, then, the first two and the main bases of classification, subdivisions in which are made according to the colour of the skin and of the tuber and the shape of the tuber.

In the last grouping, which is determined by shape of tuber, the varieties are arranged according to—(1) colour of the flesh of the tuber; (2) colour of the flower and other features of the inflorescence; (3) characteristics of the haulm.

The summer of 1921 was marked by a prolonged drought, which lasted from the middle of April until the end of July. In consequence, fears were at one time entertained that wart disease would not develop, but rains in August and September produced conditions favourable to the growth of the disease on all susceptible varieties. It is notable that, when the tubers of the early varieties were examined at the end of August when the haulms were dead, no wart disease was found, but that at the end of September when these tubers (which had been left in the ground) were again examined, they were found to bear a distinct growth of wart. In this way definite results were obtained in respect of the early sorts.

Diseases.—Frequently there was difficulty in distinguishing between the symptoms of wart disease and those of corky scab, especially when the latter appeared on the eyes of the .tuber.

A number of doubtful samples was retained for microsopical examination. Not only was corky scab found on all the underground parts including the roots, but it was also found on the stem, both slightly above and below ground, generally on the callus of a wound or crack.

Other diseases present were leaf roll, mosaic and similar constitutional diseases of the foliage, blackleg, rhizoctonia solani, blight, botrytis and ordinary scab. In addition, bacterial rot was frequently found on the tubers, especially of early varieties. In the early stages of attack, tubers affected with bacterial rot have an appearance very similar to tubers affected with blight. Bacterial rot, however, very quickly causes the tubers to turn into a soft pulpy mass, especially if the ground is moist. Blighted tubers may also, if kept moist, be attacked by bacterial rot, and will become pulpy in the same way, but bacterial rot may operate without the intervention of blight, in which case the haulms would have their normal appearance, and the blight fungus would not be present on the plant.

It was not until about the end of September that blight was noticed on the foliage and it did not in any way interfere with the trials.

Leaf-roll, mosaic disease and similar troubles, including curly dwarf, appeared to an appreciable extent, especially mosaic. These diseases have occurred every year at the trials since their inception, and from the observations made, it does not appear that they are at all freely transmissible from plant to plant in the conditions prevailing. Seed from a large number of the original stocks has been kept and planted year after year and is still apparently free from disease. As these have been grown among infected varieties for at least two years they should also have shown signs of disease if it were transmissible. Further, the plots have been planted on the same piece of ground during the three years and it does not appear that the diseases are spreading to stocks newly introduced as would be the case if the infection were transmissible through the soil.

The following is a summary of the results obtained in 1921 :—

	2nd Year Tests.
I. *Immune Varieties*—	
(*a*) Identical with standard types	26
(*b*) Not referable to standard types	24
(*c*) Type undetermined	2
(*d*) Varieties *ex* U.S.A. immune—	
No. of varieties	19
No. of distinct types	11
(*e*) Seedlings *ex* U.S.A. immune— Not referable to standard types	3
II. *Doubtful Varieties*—	
(*a*) Varieties of doubtful immunity	6
(*b*) Varieties too mixed for decision	2
(*c*) Seedlings *ex* U.S.A. of doubtful immunity	3
III. *Non-Immune Varieties*—	
(*a*) Identical with standard types	2
(*b*) Not referable to standard types	21
(*c*) Type undetermined	1
(*d*) Varieties *ex* U.S.A.—	
No. of varieties	6
No. of distinct types	4

	1st Year Tests.
I. *Varieties on which Wart Disease was not noted*—	
(*a*) Apparently identical with standard types	13
(*b*) Not referable to standard types	64
II. *Non-Immune Varieties*—	
(*a*) Apparently identical with standard types	36
(*b*) Not referable to standard types	122
(*c*) Variety undetermined	3
Stocks too mixed for decision	2

In addition a total of 1482 single tubers or seedlings were submitted for preliminary test.

It may be of interest to record the results of the interchange of varieties with the United States of America and with Germany.

American Varieties.—Of the eighty varieties from the U.S.A. included in the trials, fifty-five were named sorts, and twenty-five unnamed hybrid seedlings. Only four of the varieties were outstanding in merit, these were of the Up-to-Date type, and non-immune. In 1919 and in 1920 the early kinds died down very early and yielded only a very small crop; maincrop types also died down early and seemed to be lacking in vigour, weak in the haulm, and soft in the tuber. Many of them were extremely subject to blight. In 1921 the stocks which had been retained performed better, but the softness of the tubers and the mosaic disease of the haulms were still much in evidence, and they showed no promise of being suitable for general field culture in this country. Features of the majority of the named varieties were the large size of the tubers, the snow white flesh, and the number and depth of the eyes of the tubers.

Eighteen of the named sorts and three of the seedlings have proved to be immune, and other three of the seedlings are doubtfully immune. The three seedlings are distinct, but the eighteen varieties comprise only ten types as follows:—Irish Cobbler (4), Early Harvest, Ehnola, Perfect Peachblow, Early Manistee, Green Mountain (6), Netted Gem, Keeper, Northern King, M'Cormick.

It is noteworthy that Irish Cobbler is indistinguishable from the British variety America and that Keeper is indistinguishable from the British variety Sutton's Flourball. These sorts were first put on the market in the U.S.A. and stocks have subsequently been sent over to this country.

The varieties which proved to be non-immune included representatives of the well known "Rural New York," "Early Rose" and "Beauty of Hebron" types, also the British type "Up-to-Date."

Synopsis of American Report on British Varieties.—A very large and representative collection of British varieties, immune and non-immune, was sent to the U.S.A. in 1920. The report from the U.S.A. for 1921 states that several of the varieties were seriously affected with leaf-roll and mosaic diseases which considerably lowered their yields. The following varieties arranged in order of merit gave the heaviest yields:—

King George, Majestic, Factor, Eclipse, King Edward, Kerr's Pink, White City, Golden Wonder, Lochar and Bishop.

Great Scot, Nithsdale, Up-to-Date, Arran Comrade and Tinwald Perfection were below the average, while the lowest yielders were Shamrock, Arran Victory, America, Resistant Snowdrop and Roderick Dhu.

The following synopsis gives the outstanding results of the behaviour of the varieties towards leaf-roll, mosaic, streak and unknown diseases:—

Ally, May Queen, Great Scot, Rector, Climax, Provost and Duchess were free from disease. Epicure, Dargill Early, Majestic and Rhoderick Dhu had only 5 per cent. of their numbers affected.

On the other hand Tinwald Perfection, Golden Wonder, Resistant Snowdrop, Eclipse, Langworthy, Arran Victory, Irish Queen, Templar, King Edward, Lochar, Witchhill, Mauve Queen, Bishop and Immune Ashleaf had over 50 per cent. of their numbers affected.

German Varieties.—Twenty-two varieties were received unofficially from Germany for inclusion in the trials. These were found to comprise eighteen distinct types. Only four of the varieties proved to be immune. None of the varieties appeared to be as good as the British standard types. They were characterised as a rule by tall stems with long internodes, profuse production of flowers and berries, and a large collection of undersized irregularly shaped tubers at the root. They were, however, with two exceptions, reasonably free from foliage diseases.

Synopsis of German Report on British Varieties.—A representative collection of British standard varieties was sent over to Germany. Unfortunately the consignment was frosted in transport and so the number of tubers was reduced. The German report states that "Great Scot" was the best of the British varieties, and the only one regarded with favour.

Poultry Education and Research in Scotland.

EDUCATION.—At no time has the need for education and research in poultry-keeping been of greater importance than at the present. The number of people totally or partially dependent on poultry-keeping for a living, and the number of birds kept to the acre have increased to such an extent that many problems of breeding and disease, unknown in past years, have arisen, and now call for careful investigation and experiment. It may be useful therefore to review the facilities which are available in Scotland for dealing with these problems.

The Work of the County Instructresses.—The work of the Agricutural College County Instructresses is already well known to the average poultry-keeper. These instructresses are sent out from the Agricultural Colleges in Aberdeen, Edinburgh and Glasgow, and though sometimes an instructress has two or three counties or one very large county to work, still every part of Scotland is covered for instructional purposes in this way.

The great aim is to interest all who can keep poultry so that they may thereby increase home production of eggs and poultry, while at the same time augmenting to a greater or less extent their own earnings.

The dissemination of knowledge through the county instructresses is carried on mainly through systematic courses of lectures, single special lectures, demonstrations and systematic visitation, and in a few counties by showing what can be done on a small croft by adopting up-to-date methods. At present there are eight or nine demonstration crofts. In most cases lectures are arranged in co-operation with the Education Authorities.

Through the instructresses information is conveyed to poultry-keepers in practically every phase of the subject. Diseases are dealt with in so far as they can be, and all instructresses now have a full course on that subject before they take up duty. When microscopic and other laboratory examination of birds is required, they report to the College and send specimens. These are for the most part dealt with by the College staff, but in exceptional circumstances they are sent to the Veterinary Colleges.

School Centres.—An endeavour is being made in some counties to give instruction in poultry-keeping to the senior girls in rural supplementary schools. The instructresses visit the schools one day a week, and give theoretical as well as practical instruction. It is felt that there is a big future for poultry instruction along these lines, and these centres will tend to become more numerous in the future. The poultry usually belong to the schoolmaster, and this obviates any week-end or holiday difficulties.

Egg Stations.—There are nearly 200 private breeders who hold egg stations instituted by the Board of Agriculture, and carried on under the supervision of the local instructress. In many cases these stations become model breeding centres, where the teaching given at the lectures is put to practical effect. Efforts are being made by trap-nesting, and by the use of pedigree birds of high-laying strains to select breeding stock which will further increase the productiveness of the birds hatched from the eggs distributed by the stations.

College Farms and Experiment Stations.—The West of Scotland College Poultry Farm at Kilmarnock is the recognised training centre for instructresses. Instruction is also given to a large number of students who go back to their farms or homes to take charge of poultry there. Unfortunately, however, the more thorough training which can be given in a central institute must for obvious reasons be confined to only a limited number.

Systematic breeding and feeding experiments are also conducted, and the comparative merits of the different breeds and of different methods of housing are ascertained in so far as is possible in conjunction with the training of students. By this work much information of great value to practical poultry-keepers is obtained. The main development at the present time is the transfer of the entire poultry section to new ground, and the taking over of a considerably extended area which will give greater facilities and make it possible to do more in the future than has been done in the past.

Breeding, demonstration and experiment work of a somewhat similar nature is being developed by the North of Scotland College at Craibstone, Aberdeen, at the Ardross Poultry Croft, Ross-shire, and by the East of Scotland College at Liberton, Edinburgh.

The demand for stock from college farms is in considerable excess of the supply, and consideration has been given to the establishment of a centre at each college from which male birds tested as breeders and bred from pedigree stock with high-laying records can be supplied. For reasons of economy, however, this is not expedient at the present time.

The funds for poultry work at the Colleges are obtained principally as (1) grants from the Board of Agriculture;

(2) grants from County Education Authorities; (3) returns from sales of eggs, chicks and stock birds—even at the moderate prices charged by the College at Kilmarnock last year, the turnover was well over £2000; (4) in the case of Kilmarnock, fees from poultry students in training.

RESEARCH.—To add to the usefulness of the Colleges' work, it is necessary to have experts on breeding, nutrition and disease, working out the many problems that are met with in the daily routine of poultry-keeping. Part of the necessary machinery for this work is in existence, and a beginning has been made in a small way. The Board of Agriculture have arranged for the holding of conferences between the teaching staffs of the Colleges and the research departments, so that continuity of work may be maintained.

The Veterinary Colleges.—The Royal (Dick) Veterinary College, Edinburgh, and the Veterinary College, Glasgow, have been helpful in diagnosing the more complicated poultry diseases, and have given advice regarding treatment based on examination of diseased birds which have been sent to them from the Colleges, the Board of Agriculture and private poultry owners. Fowls are often admitted into hospital for treatment, and birds suspected of serious infectious or contagious diseases have been examined, and valuable advice to poultry-keepers has been given. But the need has long been felt for a special poultry department to deal with diagnosis and research. Avian diseases are so specialised, so numerous, and of such economic importance and the necessary research is so extensive that the constant employment of one or more specialists would be fully justified. It is very important that the study of diseases and that of feeding should be associated. The funds for the work carried on at the Veterinary Colleges have been supplied by the Colleges themselves, by grants from the Board of Agriculture, and by the fees charged for reports upon specimens sent in.

The Animal Diseases Research Association is a voluntary society which has been recently set up. In future all Government grants in aid of research into animal diseases in Scotland will be administered through the association.

The Rowett Institute, Aberdeen, which is governed by a Joint Committee of the University and the North of Scotland College, Aberdeen, has recently been opened for investigation into animal nutrition. The opening of this Institute has been made possible through an endowment by Mr John Quiller Rowett. It is maintained by this and other voluntary contributions, and by Government grants. In regard to poultry a few preliminary experiments have been undertaken chiefly as a trial of method. They deal with (1) the influence of vitamines on growth and egg production; (2) the influence of protein ratio on the rate of growth; (3) the influence of fish meal on the taste of eggs and flesh of table birds. It is intended next winter to carry out some experiments on the same lines as has been done with pigs. It is proposed to devote a certain area of ground to poultry work, and to conduct experiments with about 400 birds. There will be in the first place, straightforward feeding experiments on (1) the influence of the amount of protein; (2) the mineral matter; (3) the vitamines; commonly used foods will be given so that the results should be of great practical interest. The possibility of having these experiments duplicated at different centres is being considered.

The Animal Breeding Research Association administered by a Joint Committee of Edinburgh University and the East of Scotland College of Agriculture, depends upon the funds it receives from Government grants and voluntary contributions. Interesting problems in poultry-breeding have already been under investigation at the station set up by the Association, and it is intended that in the future, in addition to the work originating there, research should also be made into problems arising out of or connected with the investigations undertaken at the Rowett Research Institute.

It will be seen from the foregoing that while the work in regard to research in poultry matters is only in its infancy in Scotland, a substantial foundation has been laid, and provided funds are available for the adequate development of the work, results of ideal scientific and economic importance may be looked for. The special grant under the Corn Production Acts (Repeal) Act for agricultural education administered by the Board of Agriculture for Scotland, though not directly applied to poultry, is to some extent being used for this purpose through the above-mentioned research institutes.

THE following notes have been submitted by Mr. Alfred E. Moore, Honorary Director of the Incorporated Vermin Repression Society.

Rat Repression. In waging war, one of the most essential factors for a successful campaign is the constitution of an absolutely reliable intelligence service. Since, therefore, the campaign against rats and mice to be successful must partake of the nature of a world war, it is imperative that those engaged in the fight should know as far as possible all there is to know of the life-history, habits, etc., of their foes. This pre-supposes an educational campaign, which should have for its start the elementary schools of the country, and should progress through the various secondary schools and colleges, until mankind realizes the magnitude of the rat and mouse danger.

It is absurd that we should waste our time lamenting the appalling apathy which is displayed by practically everybody concerned towards the rat menace, unless and until we grapple with the problem in a practical and business like manner. Those who are informed know that the rat pathologically is a dangerous and pertinacious foe of mankind. Medical history shows that from the earliest times the rat has been a proved disease carrier, and when we say that it is a carrier of plague, ratbite-fever, spirochetal jaundice, parasitic mange, etc., we are only enumerating facts which have been given to the public by eminent medical authorities from time to time over long periods of years. It has been argued too, that the mouse is a carrier of cancer.

We know, of course, that the rat, viewed from an economic stand-point, is a serious tax upon the resources of the nation, but there are few who have any conception as to the extent of the burden. It is generally accepted throughout the civilised world that the rat population equals the number of its human hosts, and carefully checked records show that the rat costs at least 1½d. per day to feed.

A government expert gives the cost of rat feeding as ·63 of a penny per day, but my experience, spread over a number of years, shows that any estimate based upon a given diet is not dependable. For instance, a rat might very well be fed, in captivity, at a cost of ½d. per day, but in the natural state, the animal is a selective feeder with a range of diet comprising practically every article of human food: it will, therefore, be readily realized that feeding in captivity affords no adequate data.

If we take 1½d. per day per rat as being the cost of feeding, and deduct from that sum ½d. per day for garbage eating, we get a rat cost to Great Britain of £142 per minute, and this is ignoring the considerable damage done and food wasted by the rats in their foraging expeditions. Whichever way we regard the matter, it is quite clear that the rat is such an intolerable burden, that no nation of informed people should rest until every effort has been made to grapple with the problem in an ordered, determined and sustained manner.

The method of dealing with the rat pest calls for serious thought: reviewing the situation from an international standpoint, the methods so far developed are curiously puerile. It is known and acknowledged that the rat is an international menace of a formidable character, and yet so far there is no tangible evidence of co-ordination of effort. It is no new thing we are contemplating; history bears witness of public apprehension in regard to the rat, which has endured for centuries, yet it is questionable whether we in Great Britain have progressed far since the time when in the year 1762, November 19th, the Dublin Society gave a prize for a rat poison composed of oatmeal, 1 quart; rhodium, 2 drops; musk, 1 grain and 2 nuts of nux vomica finely grated.

It is, as I have said, entirely a matter of education, and I am persuaded that as a matter of prime necessity the Hygienic Commission of the League of Nations, is in duty bound to constitute an International Council at the earliest possible moment, whose object shall be:—

(*a*) To consider and formulate international maritime restrictions against rat invasion.

(*b*) To consider and formulate measures for co-ordination and synchronisation of effort in rat repression.

(*c*) To consider and formulate methods designed to bring about effective rat destruction.

(*d*) To consider and formulate methods for educating the public as to the necessity for international effort in rat repression.

(*e*) To consider and formulate an international anti-rat law consolidating all existing rat laws.

We must not, however, remain idly awaiting International action, we must put our own house in order, and to do this we must approach the problem in a generous and comprehensive manner. It is not enough that the public be warned as to the danger of the rat pest; those responsible should get together and determine upon a course of action calculated to get results. Synchronisation of *enduring* effort is an essential to success, but it is almost equally important that all effort should be marked by tact: to ride roughshod over the corns of the farmer is to court, at least, possible resistance. It cannot be supposed for one moment that anyone is going to help if no regard is shown for the well-being of live-stock and domestic animals. True, the problem is a difficult one, but, it is one capable of solution if approached in the right way and the right way is along the lines of co-operation.

Anything that it is possible to do should be done now; to procrastinate is to give our rodent enemies time to entrench, and, as in the case of Raratonga, Cook Islands, where rats have taken to climbing trees in search of food, to adapt themselves to every altered circumstance. Assuming the establishment of urban, rural and village Anti-Vermin Clubs and Guilds, there is a wide and interesting field of work before them. Their agenda would comprise (1) strengthening of the rat law; covering (*a*) penalties against re-infestation; (*b*) penalties against rat breeding except under licence; (*c*) financial provision; (*d*) widening the penalty clause against the occupier to cover in certain cases the owner or owners of property; (2) a knowledge of the life history of the enemies of the rat and mouse, and the framing of rules for their protection; (3) toxicological research: while barium and squill preparations are at the moment the safest and most useful poisons, we cannot afford to regard them as being the last word in rat-destroying agents, besides which, experience has shown that it is folly to pin one's faith to any one raticide because, rats being extremely suspicious animals, they soon fight shy of anything that patently destroys their kith and kin. This fact argues the necessity for preparing a variety of cunning baits (the constant factor in all being barium carbonate, one in four): squill preparations require special care in compounding and cannot safely be left to the unskilled, while antimony, strychinine, phosphorus and arsenic require great care in use; (4) elementary sanitary engineering and building construction; (5) rural craft; comprehending a knowledge of (*a*) ferreting; (*b*) rat-hole flushing with water; (*c*) trapping; (*d*) stink-fuse making (a stink-fuse is useful when there are a number of rat-holes and a dog only bolts them, it is made of brown paper generously

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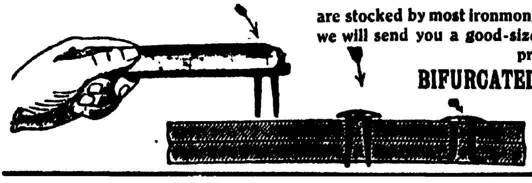

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smeared with saltpetre, cayenne pepper and charcoal); (*e*) gassing: a lot of useful work may be done by a group of youngsters with a dog, a few stink fuses, a condensed milk tin, with both ends out, and an old stocking, while useful lethal fuses, with sulphur substituted for cayenne pepper might usefully be brought into action by a senior band of rural anti-rat enthusiasts.

So much has been written about the use of virus that I feel it to be hardly necessary to advert to the subject, except to warn small-holders and farmers that its use is deprecated by the Incorporated Vermin Repression Society and is forbidden by the Army and Navy Authorities; moreover, these bacteriological vehicles of disease are frequently eaten by other rodents.

Research into Diseases of Animals.

A REPORT[1] by an Advisory Committee, appointed by the Development Commission in November 1920, has recently been issued, and should be of interest to all owners of stock. The terms of reference to the Committee were:—"To report on the facilities now available for the scientific study of the diseases of animals, to indicate what extension of those facilities is desirable in the immediate future in order to advance the study of disease whether in animals or man, and to advise as to the steps which should be taken to secure the aid of competent scientific workers in investigating diseases in animals." The Committee consisted of representatives of the agricultural industry and members of the medical and veterinary professions, and was presided over by Sir David Prain, Director of Kew Gardens. Evidence was taken from a considerable number of witnesses, among whom were representatives of Scottish agriculture.

That the Committee were fully alive to the importance and magnitude of the problem of research into diseases of animals is clearly indicated in an early section of the report.

> "The problem is widespread and intricate. Its importance may, perhaps, be gauged by the fact that the estimated value of cattle, sheep and pigs in the United Kingdom on the 4th June 1913 was probably from £180,000,000 to £200,000,000, and in 1920 from £400,000,000 to £450,000,000. The total value of British cattle, sheep and pigs exported in 1913, as given in the trade returns, was £2,272,566, and in 1920 was £4,819,401. The value of cattle, sheep and pigs re-exported was £129,252 in 1913 and £78,693 in 1920.
>
> "It is not possible to form an estimate of the annual loss from animal disease in the United Kingdom, but it must be very great. The Scottish Animal Diseases Research

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[1] *Development Commission. Report of the Advisory Committee on Research into Diseases in Animals.* London: Published by His Majesty's Stationery Office, 1922, pp. 19. 1s. 6d. nett.

Association, a body fully representative of stockowners and herdsmen in Scotland, estimate the annual loss from certain specified diseases in that country at close upon £1,000,000.

"Your Committee are not in a position to confirm or refute this estimate; they would content themselves with pointing out that the losses in England and Wales are probably four or five times as great as those experienced in Scotland. In the Union of South Africa the value of stock is estimated as £100,000,000, and the annual loss from diseases at several millions. It has not been found possible to make a similar estimate in the case of our tropical Colonies and Dependencies.

"The importance of the problem extends, however, far beyond the loss in wealth brought about by preventable causes amongst live stock. Some of the diseases of animals are directly communicable to man, but there is another aspect of even greater significance. The problem of disease and health, whether in man, animals or plants, is in reality one problem. The study of disease, it is true, has become highly specialised in its different branches, but advances in animal pathology may interact on and profoundly influence human pathology, and the reverse is equally true. Pasteur worked as directly for the prevention of animal disease as for the good of human beings. Koch's discovery of the tubercle bacillus had an equal interest for the veterinary and for the medical profession.

"Moreover, the greater part of our knowledge of human medicine, whether curative or preventive, is based either upon experiments made upon animals or upon the use of other scientific methods identical with those employed in veterinary science."

The existing facilities for research in the United Kingdom are sketched, and a brief survey is made of corresponding facilities in the Overseas Empire. Attention is directed to the fact that, while it is true that the consideration of veterinary research was, so far as the Development Commissioners are concerned, interrupted by the War, the present position is that the sum allocated to veterinary research is trifling in comparison with the sums set aside for medical, agricultural and fishery research. In this connection, it is interesting to note that the estimated expenditure by the Government of the Union of South Africa upon veterinary education and research, exclusive of building, during the year 1920-21 was £123,447; and that, of this sum, £75,000 was earmarked for laboratories and field research. The Committee draw attention "to the admirable contributions made by the Union of South Africa to the study of diseases of animals, as illustrating what can be done by a wise expenditure of public funds."

The latter part of the report suggests schemes for the extension of existing facilities for research, the training of investigators and the organisation of research. The Committee welcome the creation of an Animal Diseases Research Association in Scotland, and are of opinion that "this body should not only secure adequate contributions from farmers and stockowners, but also bring to the aid of investigators the knowledge of the agricultural community, furnish facilities for work in remote districts, and secure the full use of any remedies which may be discovered." The report goes on to say that "care should be taken that, whatever the fate of this particular scheme, permanent facilities should be provided in Scotland commensurate with the problems awaiting study and the economic issues at stake."

Agricultural Research.

WITH a view to making the efforts and results of agricultural research more widely known, the Ministry of Agriculture and Fisheries have issued a booklet, compiled by Mr V. E. Wilkins, B.Sc., which gives a summary of the results that have been obtained and the lines of experiment that are being followed out at the research stations throughout Great Britain. The book, which should be of interest to every farmer, may be obtained from H.M. Stationery Office direct, or through a bookseller, at the moderate price of 2s. 6d.

The book is divided into chapters dealing with different aspects of agriculture such as the soil, plant breeding, plant physiology, fruit growing, plant diseases, animal husbandry, etc., and under each of these headings the work of the various stations engaged in research on the subject is summarised and explained.

In the chapter on animal husbandry the work of the Rowett Research Institute on animal nutrition comes under review along with similar work carried out at the Institute at Cambridge. It is mentioned that experiments carried out at the Rowett Institute indicate that the protein requirement of an animal has been over-estimated, and that a better utilisation of the food can be obtained with less protein than is usually fed. Experiments on pigs suffering from a nutritional disease are also dealt with briefly, bringing out the result that a lack of mineral matter in the food is the cause of this "ricketty" condition. (This subject is dealt with by Dr Orr in an article on page 244.) An extensive investigation, carried out at Aberdeen, into the composition of milk is also reported; the results of this research suggest that one of the factors determining the daily volume of milk is the rate of formation of sugar in the mammary gland. These are all subjects of interest to the farmer, and the results obtained will be of practical value to him in effecting economies in the feeding of stock and getting the best results out of his crops and stock.

Under the heading "animal breeding" a brief explanation is given of the type of problem awaiting solution and the difficulties of experiment where valuable stock are concerned. The work of the Animal Breeding Research Department of Edinburgh University on sheep is dealt with fairly fully. The aim of this investigation is to find means of improving the wool of the Blackface sheep. As there can be no guarantee that, in the process of breeding for wool, the quality of the mutton will remain unaffected, it could not be expected that breeders themselves would attempt such an investigation. The question was therefore taken up by the Board of Agriculture for Scotland, in conjunction with the British Research Association for the Woollen and Worsted Industries. Four well-known breeders of Blackface sheep have agreed to co-operate by undertaking experiments on a large scale under the supervision of the Board. The experiments are to be on two different lines—(1) the introduction of fine wool characters by crossing, and (2) improvement of the quality of the wool by selection. The breed in use for crossing is the Southdown, and ten pedigree rams were purchased. The cross-bred lambs will be used for breeding this year, and the Southdown Blackface cross is also being repeated on the same scale, namely, ten rams to fifty ewes each.

The experiment in selection within the breed is being carried on at the same time, a well-known breeder having placed his whole flock of about 16,000 Blackfaces at the disposal of the Board for this purpose. Wool experts are assisting in choosing the sheep to be experimented with, and it is hoped that ultimately the wool of the whole flock will be graded up on lines which can be followed by other breeders.

At present the wool of Blackface sheep is used only for carpet making, and is principally exported to America. It is probable, however, that the import duty on such fleeces will be considerably increased by the American authorities, in which case it might no longer be commercially practicable to send Blackface wool to America, and its disposal would become a difficult problem. It is thus evident that improvement of the wool of Blackface sheep would be of great economic value to sheep farmers in Scotland, for there are many districts where this is the only breed suitable to the climatic and other conditions.

Agricultural Conditions.

THE weather during the first three weeks of March was favourable for outdoor work, but a recurrence of wintry weather in the last week interrupted the sowing of cereal crops. The month of April was cold generally, frost was frequent and there was some snow in several districts. Crops and grass were more or less seriously affected owing to night frosts and high winds. During the first fortnight of May the temperature was below the normal and growth was slow. In the eastern and south-eastern counties the weather was mainly dry, but elsewhere rain was frequent and in some districts there were night frosts. The latter part of the month was much warmer in most parts and crops progressed rapidly, but in the northern counties and the western islands the weather continued cold and wet and outdoor work fell into arrears in several districts.

Wheat was checked to some extent owing to cold weather in April and the early part of May, and while the warm weather at the end of May effected considerable improvement, the crop is still rather short. In South-West Forfar and Roxburgh some fields have had to be ploughed up and sown with oats or catch crops. According to estimates furnished by the Board's Crop Reporters, the area under the crop will show little change, on the whole, as compared with last year.

Barley is also somewhat backward, especially in late sown fields, but the crop is generally reported to be looking fairly well, and in most cases the present prospects are favourable. The total area under the crop is estimated to be about equal to the acreage recorded in 1921.

The reports on the oat crop are not quite so satisfactory as those received for wheat and barley. The crop improved during the latter part of May, but it is still backward generally and in many cases the braird is thin. Damage by grub and wireworm is reported from several districts, and charlock is more prevalent than usual in the Lothians and parts of Perth. The estimates of acreage show decreases in many districts, and it would appear that there will be a substantial diminution in the area under the crop as compared with last year.

Beans are everywhere reported to be a healthy and vigorous crop. Rye-grass and clover seeds were checked by the cold weather in April and the early part of May, and although good progress was made thereafter, the hay crop will probably prove to be lighter than usual.

Potato planting was completed at the end of May and the crop on the whole is reported to be very promising. The estimates of area show comparatively little variation from the acreage grown last year. The sowing of swedes was finished, or practically finished, at the end of May, but the sowing of yellows was delayed in many cases and the work was not completed until about the middle of June. Mangolds were all sown in May: from North Ayr it is reported that the braird is somewhat irregular.

The fruit reports are exceptionally satisfactory. Blossom was unusually heavy and, speaking generally, the prospects are very promising.

Pastures were backward during the spring months and in many cases cattle were turned out later than usual. With the improved conditions at the end of May all classes of live stock progressed satisfactorily and the milk yield increased in most districts. The fall of lambs was a full average generally, the only unfavourable reports, so far as numbers are concerned, being from South-West Aberdeen and Inverness, and in the case of hill lambs from Sutherland. The mortality has, however, been higher than usual in several cases, owing to the severity of the weather and shortage of milk. Reports of a heavy death rate have been received from Kincardine, Berwick, Shetland, Orkney, Lewis and Central Argyll.

The supply of regular workers is generally plentiful and in some cases is more than sufficient for present requirements. Specially full reports on labour were obtained at the end of May in view of the hiring fairs that were held in many districts during that month. The wages being paid are detailed in the Monthly Agricultural Report for 1st June and it will be noticed that the rates of pay generally show a downward tendency.

RECENT PERIODICAL LITERATURE.

The majority of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins, and to the original publications quoted therein, may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

The French National Wheat Committee. *H. Hitier, Comptes rendus de l'Acad. d'Agric. de France.*—In April 1920, M. J. H. Ricard, the French Minister for Agriculture, instituted the National Wheat Committee with the general object of examining all means tending to increase the production of wheat and proposing all measures likely to ensure their application.

The author reviews the results obtained in 1920 by the National Wheat Committee, through the work of its sections dealing with:—*Technique, competitions, corporate action and propaganda.* Departmental Committees, in collaboration with Directors of the Agricultural Services, Offices and Agricultural Associations, organised seed fairs, sorting sheds, wheat growing competitions, etc. Up to the present, the results satisfy the object aimed at by the creation of the National Committee and there is every reason to predict that its scope will be still further widened during 1921.

To this end M. Rabaté (General Secretary of the Committee) presented to the Committee, on December 18th, 1920, a programme of work which was approved and, among other things, has in view the following measures:—(1) a general inquiry regarding the present adaptation of various varieties of wheat to the geological, agricultural and climatic conditions of various parts of France; (2) study of the tillage of fields under wheat and subjecting to regular controlled experiments the operations at present recommended, not always with sufficient discernment and knowledge of the very varied conditions of agriculture in France; (3) cultivation of wheat in spaced lines with second ploughing, earthing-up, etc.; (4) multiplication of wheat competitions in the different departments; (5) development of co-operative societies for agricultural tools, apparatus for threshing and sorting seeds, and more especially a new form of association, namely, co-operative seed production, grouping ten, twenty, thirty of the leading farmers of each canton, having at its disposal a genealogical selection farm and a central depot for sorting and despatch: by means of control over standing wheat crops and over threshing it would be possible to deliver one or two varieties with a maximum guarantee.

In all parts of France progress in the cultivation of wheat can be made, but to obtain results quickly, efforts must be brought to bear on those parts which cultivate the largest areas under wheat, because they possess land suitable for the crop; and it is necessary, in the whole of those regions, to endeavour especially to improve the cultivation in those which give the smallest yields. M. Rabaté has compiled an interesting table dealing with this point. After having determined the average figures of areas in hectares and of yields in quintals for the period 1905-1914, he calculated for each department the coefficient obtained by dividing the number of thousands of hectares sown with wheat, by the yield per hectare. The higher the coefficient so obtained, the greater is the relative effort of improvement required.

By perusing this table both the efforts to be made and the results which may be hoped for can be ascertained, in regions such as that of the west (Maine-et-Loire, Vendée, Loire-Inférieure, Ille-et-Vilaine) sowing over 140,000 ha. of wheat in each of these departments without obtaining an average yield of 14 quintals per hectare; and such as that of the south-west (Lot-et-Garonne, Dordogne, Gers, Haute-Garonne, Charente, Charente-Inférieure, etc.) sowing over 110,000 ha. of wheat and obtaining a yield of less than 12 quintals per hectare.

Vitamines and Plant Growth. *A. Lumière, Comptes rendus de l'Acad. des Sciences.*—Certain biologists have maintained that vitamines are necessary for the growth of plants (Bottomley, *Proceedings of the Royal Society of London, Biological Science*, 1914, p. 237; Moctheridge, *Ibid.*, 1917, p. 508; Agulhon and Legroux, *Comptes rendus de l'Académie des Sciences*, vol. 167, 1918, p. 597; Linossier, *Comptes rendus de l'Société de Biologie*, April 1919 and March 1920) and this opinion, generally admitted moreover, is derived from experiments of which the author by no means contests the results, but the interpretation of which does not seem to agree either with other facts or with the numerous tests made by him personally in this field.

Not only can certain micro-organisms and fungi be cultivated in chemically definite media without any trace of vitamines, but it is also possible to ensure the growth and complete development of higher plants with nutrient solutions which are purely inorganic.

Mazé (*Annales de l'Institut Pasteur*, March 1919, p. 139) has shown that maize can accomplish its complete evolution in a liquid containing fifteen elements, all organic matter being excluded. It is hardly conceivable that certain plants, ranging from micro-organisms up to the most complex plants, can live and grow in mineral media, while others require vitamines for their development. The idea of the utility of vitamines in the cultivation of mushrooms is due to the fact that the authors who have upheld that thesis have used very poor, insufficient media, such as a mixture of ammonium tartrate and glycerine the addition to which of a few drops of an infusion of raisins will considerably improve the nutritive value of the broth.

If the minute quantity of material thus added includes vitamines, it also contains salts, proteins and carbohydrates, and it seems improper to conclude, *a priori*, that the effect noted is due to one rather than to others of these substances. The author has stated that a great number of definite chemical products, inorganic and organic used in minute proportions, would give the same results as those obtained by the addition of the infusion of raisins, and sometimes they even give better results; all these substances cannot be considered as vitamines.

Beer yeast heated to 130° C. for one hour, that is to say, having lost all its antiscorbutic properties, can be used to prepare broths which favour considerably the growth of mushrooms grown in poor solutions having for basis ammonium tartrate and glycerine.

By filtering organic liquids through fullers' earth to remove the vitamines, it is found that the filtrate deprived of these substances is more favourable to the growth of mildews than the liquid before its filtration.

Finally the author satisfied himself that organic extracts also, heated to about 250° C. up to the point of carbonisation, preserved their fertilising properties when they were added to a tartro-glycerine medium, and it is difficult to admit, in this case also, that the vitamines were able to withstand this temperature.

Vitamines are substances indispensable to life, which cannot be replaced by definite chemical compounds, precipitable by phosphotungstic acid and the reagents of the alkaloids; they are retained by filtration through fullers' earth and are destroyed by heat. Now, none of these properties is found in the substances which are capable of improving the nutritive qualities of poor media for plants. Therefore it seems clear that these substances are quite distinct from vitamines.

Weather and Crop Yields.—At a meeting of the Royal Meteorological Society held on May 17, Mr A. E. M. Geddes read a paper on "Weather and the crop-yield in the north-east counties of Scotland," of which the following abstract appeared in a recent number of "*Nature*."

The methods of correlation have been applied to find the relation between the yield of the crops in the three north-east counties of Scotland and the "weather," including in this term temperature and rainfall. There is not sufficient uniformity in all the conditions over the area from Nairn to Fife to permit of useful deductions being drawn. The final investigation was confined to the counties of Aberdeen, Banff and Kincardine for the period 1885 to 1919. The conclusions are as follows:—Cereals do better in a comparatively warm summer with rainfall somewhat in excess; root crops show less connection with the weather than cereals, but are better with rainfall below the normal; hay is influenced almost as much by the weather of the year previous as by that of the actual year of harvest. Comparing the latest values for eastern England for the same period, it appears that the most important sections of the year, so far as weather is concerned, vary from district to district. It is important not to make the district too wide in such investigations.

Plant Analysis in Relation to Manuring. *F. Münter, Jour. für Landwirtschaft.*—When, to ascertain the requirements of a soil in fertilising material, two plots are taken, one manured with nitrogen and the other with phosphoric acid and potash, the following rules can be used for estimation:—(1) If a soil lacks potash in the plots manured with nitrogen, the percentage of potash in the plants remains less than that of nitrogen, made equal to 100; if it is phosphoric acid which is lacking, the ratio $\frac{\text{nitrogen}}{\text{phosphoric acid}}$ in the plots manured with nitrogen is more than 100; if this ratio in the plots manured with phosphates and potash is less than 100, the soil lacks nitrogen.

(2) The conclusions are more certain when the ratios $\frac{\text{nitrogen}}{\text{potash}}$ or $\frac{\text{nitrogen}}{\text{phosphoric acid}}$ are equal to 100 on the plots with both phosphatic and potassic manure, because the meteorological factor is thus, as far as possible, eliminated; then, on the plots manured with nitrogen, a ratio $\frac{\text{nitrogen}}{\text{potash}}$ less than sixty indicates a lack of potash; if, on the other hand, this ratio exceeds sixty it indicates that there is sufficient potash; a similar ratio of less than forty for phosphoric acid indicates that it is insufficient and above forty, that it is sufficient.

The indications would be clearer if, instead of two plots, three were taken (manured with nitrogen, potassic and phosphatic fertilisers); the percentages noted for different cultivated plants would thus enable the state of fertility of a soil to be estimated.

Whether a general value can be attributed to such observations further experiments alone can decide; until this method has been perfected, accurate manuring experiments still remain the normal procedure for determining the fertiliser requirements of a soil.

The Manurial Value of Carbon Dioxide. *F. Bornemann and H. Claassen.*—I. CARBON DIOXIDE AND PLANT GROWTH.—Bornemann states that the weight of the crop depends very much on the production of carbon-dioxide (CO_2) in the soil. The greater the bacterial activity in the soil, the greater the production of CO_2 and the stronger the current from the soil to the leaves. That activity is favoured by the number of times the soil is worked and by organic manuring. If the above-ground, gaseous supply through the leaves is greater than the underground mineral supply through the roots, the plant is forced to store up reserves (starch, sugar, etc.) or to form organs which consume carbon more especially, such as flowers. If, on the contrary, the underground supply is greatest, and more especially the supply of nitrogenous material, the plant forms organs whose construction requires plenty of nitrogen, such as leaves, leaf-buds, chlorophyll-containing parts. Variations in lighting and in the supply of water or CO_2, according to the periods of growth in which the plant happens to be, suffice, according to Bornemann, to lead the crop in one direction or another so as to give a greater yield.

Cereals use the soil chiefly in the earlier stages of growth. Bornemann states that tillering is affected by a high carbonic pressure, but when the stalks begin to lengthen the aerial supply also tends to take the lead because of the progression of the season and of the lighting.

Leguminous plants, owing to the ease with which they obtain their requirements in nitrogen, water and mineral substances by symbiosis or by the effect of their powerful root systems, make the best use, according to the author, of high pressures of CO_2.

Experiments were made of supplying carbon dioxide to the growing crops by means of tubes placed level with the surface of the ground. Plots of winter wheat, oats, Victoria peas, barley, broad beans and white mustard were so treated, and in each case there was a control plot.

The distribution of gas to the wheat commenced after tillering. When the stems began to increase in length, the leaves of the wheat which had been given gas measured 3 to 4 cm. more in length ; the stems were thicker and, consequently, the ears were larger and thicker.

Bornemann concludes that :—(1) The formation of badly nourished grains does not depend on an excessive supply of nitrogen but on an excessive supply of carbonic acid, especially during tillering ; (2) the more humiferous and active the soil the greater the production in it of CO_2, the more extensive is the tillering, and the greater the need of dressings of mineral fertilisers (nitrogen included), and in larger quantities than is usual ; (3) if the supply through the roots is endangered, owing to drought or other causes, all agricultural operations which favour tillering should be avoided. This new idea furnishes a perfect explanation of many contradictions which are noticed in practice.

II. GASSING PLANTS WITH CARBON DIOXIDE.—Claassen criticises the partisans of carbonic manuring ; he does not deny the facts, but he does not see by what means industrial, non-biological carbonication can be applied to farming on a large scale. He considers that the increased yield would not cover the costs of interest and amortisation of the purifying apparatus, fans, and the systems of piping for supplying the gas and the cost of working them.

Reinau, replying to Claassen states, that what he calls "automatic" carbonic manuring, that is to say derived from the decomposition of organic residues in the soil, is certainly the most practical method. But he points out that by taking some trouble the blast-furnace industry could furnish for many weeks pure CO_2 in sufficient quantity. He further expresses the opinion that if the State, for reasons of hygiene, contributes to the cost of agricultural distribution of residues of sewage, it might, for the same reasons, contribute to the cost of installing tubes for delivering CO_2.

Bornemann also replies to the remarks of Claassen. He declares that he has no doubt that gassing with industrial CO_2 will cause an increase, even of 100 per cent., in the crops, but that at present it is a matter for technicians to solve the problem in the best way. In the present state of affairs non-biological gassing should be limited to kitchen-gardens and gardens, while farming on a large scale has at its disposal only automatic (biological) gassing, for which it is necessary to make a study of the best means of obtaining an increased production up to 100 per cent. It is not possible to deduce from the results of laboratory experiments, as Claassen has done, that to gas 1 hectare 100 tons of CO_2 are required, because in the open the economy of CO_2 would be greater. Experiments made on sugar beet, mentioned by Bornemann in his recent work, show, on the contrary, that the yield of sugar can be doubled, and with a good economic result.

III. Bornemann affirms that from experiments made by himself and by others it has been shown that well manured and well cultivated soil furnishes more CO_2 than the same soil not manured and badly cultivated. He tries to prove that the greater fertility of the former is due, at any rate in part, precisely to its greater production of CO_2. Experimental arrangements were as already described. However, the carbonification is not automatic ; it is obtained in the regular method (from non-biological sources) by means of pipe distribution. There was no variations in the conclusions whether the experiments were made with peas, oats, barley, potatoes, onions, turnip or cabbage; they were invariably in favour of non-biological carbonication, which gave increased production which, in the case of onions, reached 210 per cent.

The Fertilising Action of Sulphur. *J. Chanzet, Comptes rendus de l'Acad. d'Agric. de France.*—After many years of experiment, the author thinks it possible to draw a certain number of conclusions with regard to the use of sulphur as a fertilising agent.

(1) Sulphur distributed in cultivated soil has a very distinct action, shown by an increase of the crop, varying according to the greater or less quantity of organic matter existing in the soil, extent of surface in contact and the greater or less time of contact.

(2) The action is proportional to the quantity of sulphur used, a quantity which apparently should be fixed, economically and practically, between 400 and 600 kg. per hectare.

(3) The sulphur should be applied as long as possible before the period during which the plants have an intense need of nutritive elements. In other words the sulphur should be applied in the autumn or the beginning of winter and with it should be dug in farmyard or other organic manures, whereas, in the case of application early in the autumn (with farmyard manure) 200 kg. of sulphur per ha. gives good results, the quantity should be raised to 400 kg. when manuring is done in winter.

(4) The effects noticed (increase of crop, more healthy plants, greater resistance to drought, decrease or disappearance of certain diseases), are due to the fact that sulphur sets free and renders assimilable the nutritive elements in the organic matter and certain mineral matters (potash) of the soil.

A Critical Study of Pot Fertiliser Experiments. *C. B. Lipman, and G. A. Linhart, Chemical News and Jour. of Physical Science.*—Waynick, Sharp and Lipman had already demonstrated that owing to the great variability of soils and of plants, fertilising experiments of long duration cannot be of much practical value, if the factors of variation and probable error are ignored.

For this reason, Lipman and Waynick began in January 1919, a systematic study by statistical methods of the results of the pot fertiliser experiments carried out at the Ohio and the Pennsylvania Agricultural Experiment Stations.

The authors arranged the data respecting the experiment pots into eight groups according to the fertiliser; then they studied the effect of the fertiliser on each crop in the rotation, although they consider that the rotation study included in these experiments, which were themselves expensive, inadequate and fallacious, only served to complicate a situation which was already sufficiently difficult.

The data from the pot experiments at the Ohio Station, when worked out according to the statistical method showed that:—

(1) The "one element" fertilisers produced no significant increases in yield over the yields obtained from the check plots. All statements to the contrary must be regarded as erroneous.

(2) The "two element" fertilisers gave definite increases in yield over the check plots, but whether the increases are profit yielding still remains to be determined.

(3) The same may be said for the "three element" fertilisers.

(4) Different combinations of the same fertilising element seem to have produced no difference in the results.

(5) The amount of fertilisers used seems likewise to have been without significance.

(6) Even when fertilisers experiments are properly planned, and the results adequately studied by statistical methods, our present knowledge of the enormous variability of all soils and plants renders the data from any given fertiliser plot of value only on that plot. This important consideration renders

it highly probable that no fertiliser experiment as ordinarily conducted is possessed of sufficient practical value to justify the large expenditure of money, time and energy involved.

Having delivered themselves of this very severe criticism, the authors declare, that they are not desirous of making a fetish of the application of statistical study to fertiliser experiments, but wish to show that if statistical methods are not applicable to the evaluation of fertiliser experiments, the latter must be accounted of even less value and significance that the authors have accorded to them.

Formation of Nitrate in the Cultivated Soils of Illinois, U.S.A. *A. L. Whiting and W. R. Schoonover, Univ. of Illinois.*—The aptitude of a soil to produce a large amount of nitric nitrogen, sufficient to satisfy the requirements of growing crops, except for leguminous crops, and this in spite of washing by rain, constitutes one of the principal factors of a greater and more economic production of food, whence the importance of systematic study of nitrates in cultivated soils. A series of observations, which lasted a year, was undertaken with this object on experimental plots at two farms of the Agricultural Station of Illinois. It was thus possible to measure systematically the percentage and rate of formation of the nitric nitrogen in the soil, up to a depth of 15 cm., in soils treated and cultivated in different ways, and it was possible to determine their influence as well as that of the season and rainfall.

The principal factor which favours the production of nitrates in the soil is the manner in which the soil is treated. Climatic factors govern the course of the formation of nitrates, but the quantity produced depends on the treatment of the soil; crude mineral phosphate is an important element for increasing the production of nitric nitrogen, and this effect is greater with good rotations of crops than if the latter are inadequate, but a complete application of organic matter (plant debris and farmyard manure) of phosphate and lime causes a greater and more rapid formation of nitrates than if organic matter and lime, or organic matter alone, are used. This application will satisfy the requirements of abundant crops, and, at the same time, dispense with the purchase of commercial nitrogenous fertilisers.

It is proved that the nitrogen of clover and of sweet trefoil, dug in during April and May, furnishes nitrates for the subsequent rotation crop, and although farmyard manure is equally efficient for nitrification, especially if it is applied with phosphate and lime, it does not nitrify to the same extent and with the same speed as the above mentioned leguminous plants Active organic matter also greatly increases the provision of nitrogen in dark sandy silt soils. The best rotation for the formation of nitric nitrogen is that in which leguminous plants are used as green manure, and where two crops, consuming large quantities of nitrogen, are not planted in succession.

The rate of formation of nitric nitrogen varies according to the season in the following manner: –

(*a*) At the end of spring and beginning of summer, the period of greatest formation and accumulation; the optimum of temperature and humidity is found at this season;

(*b*) At the beginning of autumn there is often a second period of activity in the production of nitrogen, which constitutes a second degree of optimum for nitrification;

(*c*) At midsummer, small production of nitrates, unless the weather is cool and there is a sufficient amount of humidity;

(*d*) In winter the formation of nitric nitrogen has never been recorded.

The most efficient cultural factor which reduces the losses of nitrogen by lixiviation is the presence of vegetable debris; a growing crop also decreases these losses.

The greatest consumption of nitric nitrogen, estimated by the corresponding diminution of nitrogen in the soil coincides for maize with the period of greatest visible growth, which takes place generally between June 25 and July 15; for wheat and oats the greatest consumption takes place earlier, towards the middle of May or the beginning of June, and, in the cases investigated, earlier with wheat. The period of greatest consumption of nitrates, as well as the rate and percentage of their production, are directly connected with the treatment of the soil; thus, according to the author, plots suitably treated gave earlier and greater quantities of nitric nitrogen than those not so well treated, and in the former the renewal of the formation of nitrates took place also earlier and more abundantly.

Production of Mineral Phosphate in the United States in 1920.—According to data collected from all the producers at the commencement of April 1921, by the United States Geological Survey the production of phosphates in the United States in 1920 greatly exceeded that of any previous year.. The quantity mined and sold was 4,103,982 long tons, that is to say about 1 million tons more than in 1913 when the production was exceptional. The total sales amounted to $25,079,572 that is to say more than double those of any other year.

The average sale price of the whole output was $6·11 per long ton as against $5·10 per long ton in 1919.

The production in Florida was more than doubled, the quantity of pebble extracted having increased by more than 1·5 million tons. South Carolina produced 27 per cent. less than in 1919; Tennessee increased its production by 100,000 long tons, or 18 per cent. and an increase of 223 per cent. is reported in the production from Idaho and Utah. The production of the Western States of the Union (chiefly due to Idaho), amounting to 17,000 long tons in 1919 rose sharply to 55,000 long tons or more in 1920.

TABLE I.—*Mineral phosphates exported from the United States in* 1920.

	Quantity.		Value.
	Long tons.	Metric tons.	Dollars.
High grade hard rock . .	334,891	349,610	4,496,457
Land pebble	693,355	704,481	5,593,814
Other classes	31,761	32,271	500,904
Total . . .	1,070,012	1,086,362	10,591,175

Watering by Imbibition in Market Garden Cultivation. *E. Stappaert, Revue Horticole Belge.*—The system proposed by the author is intended especially for greenhouses. He tried it in 1917, and the results have been so conclusive that he has generalised its use in all the greenhouses belonging to the State School of Horticulture at Vilvorde used for the cultivation of vegetables in plots. At a depth of 35 to 40 cm., drainpipes 7 cm. in diameter are placed in the ground, without joints, but end to end as if for drainage. These pipes are laid level, the lines of pipes being about 1·50 metres apart. At the two ends of the lines the last pipe is fitted with another pipe placed vertically so that water may easily be poured down it.

If the soil of the greenhouse is about level, and if its length does not exceed 40 m., the lines of pipes are arranged lengthwise with the greenhouse. In case the ground is inclined, or if the length exceeds 40 m., the pipes are placed so as to form lines parallel with the gable ends of the greenhouse This arrangement is necessary so that the lines of pipes may be level and always about 35 cm. below the surface of the soil.

When watering is to be done, water is allowed to flow through the pipes by placing the end of a rubber tube into the pipe placed vertically, the other end of the rubber tube being fitted to the nearest water tap. If water is not laid on it is poured into the vertical pipe from watering cans. The water is allowed to flow until it is seen, by looking down the vertical pipe placed at the other end of the line, to have reached the end of the line. The end of the rubber tube is then moved to the vertical pipe of the next line.

When the first watering is being done, especially if the lines of pipes are fairly long, it sometimes takes more than an hour for the water to reach the end of a line. This is because the earth absorbs so much at each joint of the pipes where the water escapes.

With the second watering the time required diminishes, and after three or four operations it scarcely takes a quarter of an hour for each line.

The water which flows in the pipes escapes into the soil at each junction of the pipes, saturates the surrounding soil and, by capillarity, mounts to the surface of the soil.

In successive waterings the water is poured alternately into the vertical pipe at each end of a line.

With this system it is also possible to distribute to each line of pipes the rain water which falls on the roof of the greenhouse, and to distribute it over the whole area of the covered soil. With this object a system of pipes 8 to 9 cm. in diameter, such as are used for hot water heating, is connected with the down-pipe from the greenhouse roof, and divided into two sections so that each section forms a conduit joining up one end of each of the lines of pipes in front of which it is placed.

So that each line of pipes shall automatically receive the same amount of water, a small gas tube of about 1·5 cm. gauge is grafted on the pipe which holds the rain water, and rising perpendicularly from it is bent at a certain height and turned downwards to enter the line of drain pipes. If all the bends of the small tubes are exactly on a level these tubes constitute so many communicating vessels, and each will divert the same quantity of water into each line of drain pipes.

The drain pipes used are 30 cm. long.

A New Preparation of Copper Aceto-Arsenite (Paris Green). *K. Escherich, Deutsche Landwirtschaftliche Presse.*—The use of Paris Green (copper aceto-arsenite) in the form of powder presents various difficulties. In order to obviate these the insecticide has been recently placed on the market in Germany in tablets, each about the size of a tablet of chocolate, and containing sufficient of the compound to make a hectolitre of spraying-mixture. Each tablet is divided by grooves into five smaller divisions, one of which is enough to make twenty litres of the mixture for spraying. Each of these smaller divisions is, in its turn, subdivided transversely, into equal parts, one of which is sufficient for preparing 10 litres of spray. In this manner, the weighing of the substance, an operation entailing loss of time and of material, is completely dispensed with.

Further, the neutralising agent has been incorporated into the tablets, so that the troublesome business of adding lime is wholly unnecessary.

Another and more important practical advantage possessed by the new preparation is its considerably increased power of suspension, as compared with "Uraniagrün" (the name usually given in Germany to aceto-arsenite of copper in powder form).

The experiments made by the authors have proved the new preparation to be entirely satisfactory in every respect.

The Increase of the Hessian Fly. *W. R. McConnell, U.S. Dept. Agr. Bull.*—It has been noticed that an outbreak of Hessian Fly (*Phytophaga destructor*) may spread with comparative rapidity over a large area from a limited source of infection, and this observation led the author to study the rate of multiplication of the species in the hope that therein he might discover the explanation. In so doing he rejected as unsatisfactory the older methods of confining female insects in cages—since these always interfered with natural conditions—and attempted a new method of counting the eggs in the body of the females. The numbers of eggs were found to vary in the different generations throughout the year, and separate counts had to be made for each generation. The general result has been to show that the rate of multiplication in the Hessian Fly is much higher than had been realised. A single female of the spring brood will lay on an average 230 eggs; half of these will produce females, each of which may produce an average of 285 eggs, giving a total product of one female at the end of two generations, of 32,775 individuals. Fortunately, natural enemies, birds and insect parasites, step in to check this glut of Hessian Flies. Actual observations of the effects of such natural agencies were made. In one field carefully studied in the autumn of 1919, the stubbles were found to be infested to the extent of 4,900,000 puparia an acre. These were examined just before hatching time arrived and only 4·4 per cent. were found to be alive; and only about one third of these, or 1·4 per cent. actually developed into healthy flies. Even this tiny survival, however, meant the presence of some 68,600 flies an acre in the autumn of 1919, and the females of the batch, numbering say 41,160, would lay sufficient eggs to develop in young wheat sown in that autumn into some 9,466,800 flies—a much smaller number, the author says, than was anticipated! Surely this count goes a long way to explain the sudden outbreaks of Hessian Fly ravages; and justifies the farmer in praying for the presence of the parasites and unfavourable weather which alone seem able to keep the increase within reasonable bounds.

The Carrot Fly destroyed by Paraffin, *F. Ironside, Gardiners' Chronicle.*—The writer applied wood-ash soaked in paraffin, at the rate of a quart of the latter to a bushel of the former, to a bed of carrots badly infested with Carrot Fly (*Psila rosae*). The ground, being dry, was first well watered, and the wood-ash was subsequently spread thinly over the bed, at the rate of two bushels for an area of 300 square yards. The paraffin was then washed well down to the roots of the carrots by the application of water, and examination a few days later showed that all the grubs about the roots had been killed.

The Destruction of Cockroaches or "Black-Beetles." *F. Laing, British Museum (Natural History), Economic Series,*—Two kinds of cockroach which have at one time or another been brought to Britain by accident have settled down as permanent nuisances. The most abundant is the common cockroach or "black-beetle," a familiar pest in many a kitchen and pantry, and the smaller German cockroach, which has been found in recent years in enormous numbers in certain lake houses, restaurants and the like. Although cockroaches have not been proved to carry disease, they contaminate food, their odour is repulsive and they may do actual damage, so that their destruction is desirable. The following methods are recommended:—I. INSECT POWDERS: (*a*) *Sodium fluoride*, three parts, to *Pyrethrum* powder, one part; the mixture to be scattered about the haunts of the cockroaches at night, and the dead swept up and burned in the morning—a cheap mixture, harmless to domestic pets. (*b*) Powdered *Borax* mixed with chocolate or with *Pyrethrum* powder. (*c*) Plaster of Paris, one part; sugar, two parts. Both mixtures to be used as (*a*). (*d*) *Phosphorus paste*, to be spread on pieces of cardboard placed in the runways of the insects—a dangerous poison where there is a chance of other creatures than cockroaches reaching it.

II. TRAPS; to be used where powders might contaminate food. The most successful baits have been found to be stale beer or peeled bananas.

III. FUMIGATION: (*a*) *Sulphur dioxide*, made by burning brimstone, at least 2 lbs. of sulphur per 1000 cubic feet; the sulphur to be placed on an old iron shovel or tray, the room made as air tight as possible and left for at least an hour before it is ventilated again. (*b*) *Carbon bisulphide*, for pantries, sculleries and bathrooms; 2 lbs. per 1000 cubic feet of space, placed in shallow vessels on a bracket or shelf and the room closed for about thirty-six hours. A remedy dangerous in amateur hands on account of the inflammability of the vapour, and of its explosiveness when mixed with air.

IV. HEAT. A temperature of 130° F. is fatal, but the method is not easy of application in dwelling-houses.

Experiments made in the United States on the Dry-Air Sterilisation of Dairy Utensils. *S. H. Ayers and C. S. Modge, Jour. of Dairy Science.*—The authors, with a view to testing the possibility of applying to the practical dairy-industry the process of sterilising by means of a current of hot air, carried out experiments for the purpose of determining the temperature of the heated air and the length of time required to sterilise milk-cans at farms, and also in places like dairies, where the sterilisation process must be continual.

Taking as a basis the data of preliminary experiments made in the laboratory which showed theoretically that good results seemed likely to be obtained in sterilising dairy utensils, especially since the temperature for the purpose could be kept below that used in the preliminary experiments the authors proceed to sterilise milk-cans.

Three milk-cans of the capacity of 3·8 litres which had contained sour milk, or cream were used. In order not to destroy the bacteria, they were washed in warm water at 45° C. without soda. Two of the cans were then exposed for fifteen and thirty minutes respectively to a current of air heated to 110° C. The third can served as a control. Six minutes was necessary to raise the temperature to the required height. Thorough sterilisation could be effected by exposing the milk-cans for thirty minutes to the current of hot air; fifteen minutes, however, did not give satisfactory results, as is shown by some figures taken from the table giving the details of the experiment. Thus, the number of bacteria per milk-can rose respectively to 1,400,000,000 - 1,570,000,000 – 3,111,000,000 in the control cans; to 800 - 1500 – 4200 respectively in those heated for fifteen minutes, whereas in the case of the milk-cans heated for thirty minutes, the number had greatly decreased, being only 200 – 200 – 400 respectively.

While heating in this manner up to 110° C. amply suffices for the sterilisation of all dairy utensils used in farms, it is not enough for continued sterilisation, such as is practised in dairies, or where a large number of milk-cans have to be sterilised in a short time. The authors tried to shorten the duration of the action of the hot air current by raising the temperature in the cans to 120 – 130 – 140° C. respectively. The milk-cans, which were of a capacity of 3·8 litres, were subjected to the same treatment as in the previous experiments.

The best results were obtained by raising the temperature of the milk-cans from 44·4° C. (after washing) to 142·2° C. and by exposing them to this temperature for two minutes. Then the number of bacteria varied between 100 and 700 per milk can.

CONCLUSION.—Sterlisation by means of a current of hot air is applicable to dairy utensils. How to render the process industrially practicable is a question of technique and expense.

Animal Epithelial Products in Rations Fed to Wool-Producing Sheep.

M. Zunty, *Biedermann's Zentralblatt.* A means of increasing wool-development in sheep without the use of foods with a high protein content.

As is well known, sulphur-containing cystine, an albuminoid derivative, is the substance chiefly concerned in the growth and development of wool. Only 0·3-2·5 per cent. of it is to be found in the protein of nutrient liquids, and it sometimes occurs in even smaller quantities in protein food substances, whereas the cystine content of the horny constituent of wool is as much as 7·3 per cent. Thus, in order to obtain the necessary amount of cystine, considerable quantities of protein have to be ingested. Further, it has been found that after the decomposition of the protein and the elimination of the cystine, all the other matters that make up food protein are lost, as regards the formation of animal albuminoids, which explains the relatively large quantities of protein required in the ration, in order to obtain a good wool-yield from sheep.

As foods rich in protein are lacking in Germany, the author, with a view to economising plant proteins, tried to give sheep all the nutrients required for inducing the growth and development of their wool by adding to their rations, hair and other epithelial products that had been rendered digestible by chemical action. The results of the experiment were satisfactory; four sheep were given equal amounts of disintegrated straw and mangolds, the quantity being sufficient to maintain the weight of the animals.

Of the four sheep used in the experiment, two were given from 9-10 gm. of digestible horn in their rations per head per day.

After the experiment had lasted for four months the fleeces of these animals were much finer than those of the sheep which had been given no horn, and microscopic examination showed that the diameter of the staple exceeded by one-third that of the wool produced by the control animals.

Factors Relating to the Birth-Weight of Pigs. *W. J. Carmichael and J. B. Rice, Univ. of Illinois.*—These records include 720 litters containing 5840 pigs, and were made during the years 1903 to 1916 inclusive under the management of the Animal Husbandry Department of the University of Illinois. The records are based on the influence of the following factors:—(1) Length of gestation period; (2) Size of litter; (3) Age of dam; (4) Breed; (5) Time of year; (6) Order of farrowing: (7) Succeeding litters from the same sow.

(1) LENGTH OF GESTATION PERIOD.—The records obtained from 549 litters showed a somewhat wide range, 98 to 124 days, in the length of gestation period, with an average of 114·58 days. However, 93·6 per cent. of the litters were farrowed between the 111th and 119th days, and 73·8 per cent. between the 113th and 117th days.

Although there may be a slight variation in length of gestation period due to age, the general belief that older sows have a gestation period one to three days longer than younger sows seems to have no very sound basis.

There was a negligible, if any, correlation between the length of gestation period and the birth weight of pigs, but there was a tendency for some of the litters, which were carried longer than the average, to be smaller than those which were farrowed earlier than the average.

A study of the sex of the pigs in relation to the length of gestation period, shows no apparent tendency for either sex to predominate.

(2) SIZE OF LITTER.—In this study the average size of litter was 8·1 pigs. The average weight of a litter is about 20 lb. This weight varies almost in direct proportion to the number of pigs in the litter.

The average weight of pigs in litters with fewer pigs than the average was 2·67 lb., and in litters with more pigs than the average it was 2·47 lb.

There is no noticeable correlation between size of litter and sex. It is, however, interesting to note that in a total of 5657 pigs, 51·9 per cent. were males and 48·1 per cent. females. The litters larger than the average contained 10·5 per cent. dead pigs, and the litters smaller than the average 7·7 per cent. The proportion of males (56 per cent.) among those farrowed dead was greater than the normal predominance of males over females.

(3) AGE OF DAM.—On the whole, the belief that young sows produce smaller pigs than the older sows has been confirmed by these researches. The average number of pigs from sows 1 to 1½ years old was 7·5, and from sows 2 years old or more 8·6, with average weights of 2·44 lb. and 2·61 lb. respectively. The older sows, therefore, farrowed a greater percentage of dead or immature pigs than the younger sows. The age of the sow appeared to have no effect on the proportion of males to females.

(4) BREED.—Somewhat wide differences appear to exist among various breeds as to the length of gestation, size of litter and birth weight of pigs. Berkshires had appreciably the longest gestation periods (115·4 days).

(5) TIME OF YEAR.—Results lead to the conclusion that it is very doubtful whether any variations exist in farrow which can be attributed to the season.

(6) ORDER OF FARROWING.—Of the first farrowed, the proportion of males (59·4 per cent.) was higher than the normal ratio of males to females. In comparing the averages of the same sex, as well as that of both sexes, it was found that the average weight of the first farrowed was somewhat heavier than the average of the later.

(7) SUCCEEDING LITTERS FROM THE SAME SOW.—In most cases there was an increase in the number of pigs per litter and in the weight of individual pigs until the fourth litter, at which time the sows were 3½ years old. However, attention is drawn to the fact that to obtain the maximum and economical production other factors than the number of pigs and their size should determine the age at which sows should farrow the first and succeeding litters.

Pigs and Roundworms. *B. H. Ransom, Yearbook, U.S., Dept. of Agriculture.*—The common roundworm *Ascaris lumbricoides*, a fairly frequent human internal parasite, has long been recognised as a troublesome pest of pigs, causing digestive troubles, interfering with growth and generally impairing health. It was known that the worms were swallowed in the egg stage along with pasture and that the egg covering dissolved in the host's food-canal, and it was supposed that there it completed its growth and development. But investigation has shown that the life history is somewhat more complicated, and that the worm makes, as the American author puts it, "a ten-day tour through the body." The essence of the story is that the newly hatched roundworm, one hundreth of an inch long, leaves the intestine for the blood vessels, in the stream of which it is carried to the liver, through the heart, and eventually to the lungs. Here if it be present in numbers it may cause serious hæmorrhages and possibly fatal pneumonia. After a few days in the lungs it passes up the windpipe to the pharynx and thence down the food-canal to the intestine which it reaches some ten days after the commencement of its journey, having increased some ten times in length during its circular tour. In the intestine it continues to develop, reaching maturity about two and a half months after it was engulfed as an egg.

It has been found that young pigs are not only more susceptible to infection than old pigs, but also that, when infected, they develop much more serious lung conditions than do adults.

The most effective method of combatting the spread of roundworm is attention to the conditions of sanitation in which the pigs live. It is especially necessary that clean and sanitary farrowing pens should be provided, into which sows are placed a few days before farrowing; and that young pigs should be excluded from polluted pens and pastures.

Transmissibility of Foot-and-Mouth Disease to Man. *C. Lebailly, Comptes rendus de l'Acad. des Sciences.*—Classic treatises on human medicine and on veterinary medicine, teach, on the strength of experiments made in Germany in 1834, that foot-and-mouth disease (aphthic fever) is transmissible from animals to man through milk. Periodically, observations are published which seem to confirm this. But the author, having carried out an inquiry which he details in this note, thinks it justifiable to conclude from his observations and experiments that bovine foot-and-mouth disease and human aphthic stomatitis are absolutely distinct diseases, since the former cannot be transmitted experimentally to man nor the latter to cattle.

The Frozen Meat Industry in Brazil. *La Revue Générale du Froid et des Industries Frigorifiques.*—The frozen meat industry in Brazil is of quite recent date, since it began in 1914; the first consignment to London, 1415 kg., was made in December of that year by the Osasco and Barretos packing houses in the State of São Paulo.

During the war the enormous demand for frozen meat required for the allied armies gave this industry a remarkable impetus; the following statement shows the total shipments from Brazil each year up to 1920:—

	Tons shipped.	Values in thousands of paper *milreis*.[1]
1914	1,415	--
1915	8,514	6,121
1916	33,661	28,192
1917	66,452	60,233
1918	60,508	60,755
1919	54,094	60,183
1920	63,600	67,213

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[1] 1 paper *milreis* = 16 *pence*.

From an examination of these figures it would seem that the demand due to the war resulted, as principal effect, in the sudden creation of the meat industry and that this industry, which has now reached the stage of regular production, shows a tendency to develop normally, the price of Brazilian meat tending at the same time to keep level with those of other similar markets. At present there are about 35 million head of cattle in Brazil.

For several years the Federal Government has been making greater efforts to introduce well-bred bulls into the country. It has instituted bonuses for breeding, allowed duty-free importation of bulls, and encouraged cattle shows and fairs. The Minister of Agriculture has recommended the following measures as capable of giving good results:—

(1) *Restriction in the importation of bulls to two or three breeds at most:*—(Shorthorn, Polled Angus, Hereford) with the object of improving the live weight of the cattle. On its part the Union of Breeders of Rio Grande do Sul recommends, for cattle intended for slaughter, that after experimenting, one or other of the three breeds should be definitely adopted so as to create a fixed breed by the introduction of a single strain in the indigenous cattle.

(2) *Generalising the practice of keeping cattle in pens:*—Up-to-date Brazilian breeders have been content to import bulls and let them run free among the herds in the open all the year round. It was soon discovered, and this was notably the case with cattle belonging to the Brazil Land, Cattle and Packing Co., that these bulls, imported into Brazil at great cost, could not stand the diseases which raged in the country:—foot-and-mouth disease, red water, anthrax, etc.

The frozen meat from Brazilian cattle has been recognised as capable, as regards quality, of comparison with the best Argentine, Uruguayan, Australian or Canadian meat on the English and French markets.

Argentine cattle yield on an average 500 kg. of meat per animal, whereas in Brazil the average barely reaches 250 kg.

The possible export would be about 700,000 head, which at an average weight of 250 kg. per head, would give a total of 175,000 tons of meat.

At present the capacity of industrial production is far from reaching this amount.

Freezing Broken Eggs. *A. Monvoisin.*—The author describes the freezing of liquid eggs as an industrial means of preservation. The frozen eggs of commerce (hen's eggs and sometimes duck's eggs) are prepared in China, Japan and North America.

The plant required includes:—(1) Cold storage to preserve the eggs, before they are broken, at a temperature of 0° to +4° C.; (2) a testing room kept at a temperature of +10° to +13° C.; (3) a well-lit breaking room at a temperature of +15° to 18° C.; (4) a freezing chamber with a temperature of between −12° and −18° C.; (5) a room for washing and sterilising the utensils. All the apparatus is in non-rusting metal and capable of standing daily sterilisation without deterioration.

Eggs freeze at about −3° C.; the shell cracks and lays bare the membrane inside the shell, which renders the egg very vulnerable and easily invaded by microbes when thawed. To avoid these defects it is better to get rid of the shells of eggs to be frozen.

The worker breaks the eggs one at a time by striking the egg against the sharp edge of a metal blade. The egg is emptied into a glass, so that a bad egg which has escaped the test can be eliminated. An experienced worker can break and empty twelve to sixteen eggs a minute. The yolks are mixed with the whites, or they are kept separate; the yolks can have sugar (1 per cent.) or salt (0·7 per cent.) mixed with them. The liquid eggs are placed in tins which usually contain 13·5 kg., the tins are soldered and then taken to the freezing chamber, where they remain for about thirty-six hours at a temperature of from −12° to −18° C. Preservation is subsequently effected in cold storage, with or without ventilation at −6° or −8° C. Preservation can be prolonged for a year or more; it is, however, noticed that in this case the product thickens slightly and sometimes a slight oily film forms on the surface.

An American company, the "Amos Bird Co." at Shanghai deals daily with one million eggs. The yolks and whites are dried and frozen, or frozen only. These products are sold in America. The factory employs 700 workmen and the processes of manufacture are kept secret.

Milk-weighing Balance. *G. Goudot, Jour. d'Agric. pratique.*—The author describes a good type of milk-weighing balance used by cheese makers in Franche-Comté.

This balance is a steel yard of which the shorter arm supports the pail which holds the milk; the longer arm, bent in a circular arc, ends below in a weight calculated so that when the pail is empty the point of the hand fixed on the upper part of the arm, points to zero on the dial at the top of the apparatus. On this dial, starting from zero on the left, are marked large divisions each of which corresponds to 1 kg.; each of these divisions is divided into four parts corresponding to ¼ kg. respectively. Each kg. is reckoned as being equivalent to 1 litre of milk which in practice causes no objection. For weighing, the milk is poured into a wire-mesh strainer designed to strain out impurities suspended in the milk. This strainer is fixed to a support by means of an iron pin and is moveable round this support so that its lower aperture is over the pail while the milk is being strained and so that it can be moved to one side to lift the pail when filled.

The working of this weighing machine is therefore very simple. But for the balance to weigh accurately it must be quite vertical and the feet that support it should be firmly bolted to the floor of the room where the milk is received, otherwise the slightest disturbance may interfere with the accuracy of weighing. It is further necessary, for accurate weighing, that the axis of the beam should be kept dry, as rust would cause irregular weighing.

Effect of Mechanical *versus* **Animal Traction on Resistance in Ploughs.** *M. Castelli, L'Italia agricola.*—Capt. Julien (*La Motoculture*) admits that a plough, owing to the fact that it is drawn by a tractor which compresses the ground in front of it, meets with resistance 30 per cent. greater than it would meet with if drawn by animals; he admits, therefore, that 30 per cent. of the tractive power measured at the draw bar should be attributed to the tractor. The increased power rendered necessary by the use of the tractor may amount to as much as 50 per cent.

To clear up the question as to whether this increase should be attributed solely to the compression of the soil caused by the tractor, the author investigated the causes which might affect the unit effort (per sq. dm. of section ploughed) of the plough, assuming that the comparison is between ploughing done in the same soil at the same depth. He limits his consideration to the influence of different conditions of ploughing respectively with a tractor and with animals which are :—(1) The weight of the plough; (2) the direction and position of the line of traction; (3) the compression of the soil; (4) the speed: further, the errors which may be made in measuring the average force and the depth of ploughing have an importance which is not negligible.

Weight of the Plough.—Ploughs for mechanical traction are always heavier than those drawn by animals by at least 10 kg. per sq. dm. of section ploughed; in soils with resistance of from 60 to 100 kg. per sq. dm., an increase in the resistance or tractive effort of about 10 per cent. and often more, results.

Direction and Position of the Line of Traction.—The author considers separately the effect of the slope up (angle between the line of traction and the horizontal) and that of the slope down (angle between the line of traction and the vertical plane of the side of the furrow).

In the case of animal traction the coupling point of the line of traction is always high (yoke for oxen or collar for horses), and it is always possible, by lengthening or shortening the draught, or even by raising or lowering the coupling point of the plough to obtain the slope which requires the least tractive effort, or else to obtain the minimum horizontal projection of that effort more easily. On the other hand, in the case of tractors, the line of traction is always very nearly horizontal; in certain cases the author has noticed that it was even inclined downwards, so that the force was not at a minimum, and that generally it is greater than in the case of animal traction.

The effect of the slope downwards of the line of traction is in practice still more important. It is very variable and greater for tractors of great breadth, which move entirely on the fallow with a short central coupling (in the centre of the axle of gripping wheels), for ploughing with a single plough body. The author considers that, when these conditions are simultaneous, they may cause an increased tractive effort which may exceed 30 per cent. On the other hand this effort may decrease to nil if the conditions are the reverse (tractors which move with one of the fixed wheels in the furrows); long draught; coupling to a bar jutting out sideways; use of multiple ploughs ploughing widths little less than the breadth of the tractor.

Soil Packing.—Naturally in all but exceptional cases, the compression of the soil by the passing of the tractor increases its hardness; but up to what depth is the effect of the pressure noticeable by increasing the resistance to the edge of the ploughshare? The effect is more noticeable in the case of shallow ploughing, and perhaps only noticeable in such cases; but until the contrary is proved, the author thinks increases of 30 per cent., or even of 20 per cent., in the resistance may be excluded, since, according to him, the compression of the soil may very considerably increase the resistance to the ploughshare, much less that to the coulter, and scarcely at all that to the mould-board; so that to get total increased resistance of 30 per cent. an increase of 50 per cent., in round figures, in the resistance to the ploughshare would have to be allowed, which is at least doubtful.

Speed of the Plough.—It is generally thought that the resistance to the plough increases with the speed. But the author suspects that effort has often been confused with power. Often an increased speed improves the quality of the ploughing by helping disintegration and turning over, with a presumable increase of effort which should not be attributed to the tractor, since it is compensated for by better ploughing.

Influence of the Methods adopted on the Measurement of the Tractive Effort and of the Depth of Ploughing.—The tractive effort is generally deduced from the displacement of a spring placed between the motor and the plough; the deviation of the line of traction from the line of movement is therefore not taken into consideration. The additional error made in neglecting the slope is compensated, wholly or in part, by the decreased work required with a moderate slope up; the additional error made in neglecting the slope down has to be added to the increased work due to the slope down itself. The measurement of the depth of ploughing is below the actual in the case of mechanical ploughing, because it is made from the surface of the fallow next to the furrow which has been compressed by the tractor; in the case of animal traction the measurement is above the actual, either owing to the raising up of the soil at the edge of the furrow or to the constant sideways movement of the plough.

Summary.—It is true that the resistance, and consequently the mechanical work, required for ploughing, is considerably greater when the plough is drawn by a tractor than in the case of animal traction, but the greater work (also noticed with windlass traction) should be attributed in a small degree to the compression of the soil and in a greater degree to various causes, such as the heavier weight of the plough, the downwards slope of the line of traction, the greater speed, and to systematic errors in the measurement of the depth of the furrow.

Regarding remedial measures it is not necessary to trouble about the greater speed, since the greater resistance which results from that cause is compensated for by better ploughing; the greater weight is necessary, up to a certain point, to give greater stability which is indispensable owing to the greater speed; beyond that limit it should be avoided either by good material or by eliminating complicated mechanism for raising, steering, etc.; the effect of deviation of the line of traction, especially of the slope down, should have the serious attention of manufacturers and agriculturists. Means of eliminating errors of measurement of the depth of the furrow are known (use of pantographs, accurate horizontal planes for reference, etc.) but are laborious, and they are not always applicable to tests laid down in competitions.

The "Mav" Cultivator for Rocky Land. *E. Marre, Le Progrès Agricole et Viticole.*—This new tillage instrument, designed especially for the rocky lands of the Causse, but which would be serviceable on all stony soils, even when not calcareous, has been thought out and constructed by M. Béteille, Matériel agricole et viticole (Mav), rue Pasteur, Béziers.

It has a rigid strong frame of special steel with rivetted joints. The working pieces, of cast steel with interchangeable parts of hard steel, can move out of the way on meeting abnormal resistance, such as that of a rock, they are kept in place or brought back into working position by powerful springs with a very small movement, which saves them from being bent or broken. The working pieces are fixed to the frame by means of bolted rings bearing the axis round which these pieces move.

The penetration of the teeth into the soil is brought about by means of a crank axle governed through a screw by a flywheel, a chain and a roller lifting the front at the same time. A seat situated opposite the flywheel enables a man to regulate the depth of digging while working.

The weight of the apparatus is about 500 kg. It can loosen a strip of ground 1·70 metres wide, in very favourable soil an average depth of 15 cm. can be reached if necessary, by passing twice over the ground, but according as the difficulties (hardness of the ground, the length of time it has been fallow, etc.), increase, it will obviously be necessary to pass more often over the ground to attain that depth. When that depth is reached, the soil is ready for sowing.

LEGAL DECISIONS AFFECTING AGRICULTURE.

THE following cases have been selected from recent decisions of the Courts as being of general interest:—

ARBITRATION PROCEEDINGS UNDER THE AGRICULTURAL HOLDINGS (SCOTLAND) ACT, 1908.

Single Arbiter—Claim not timeously lodged. *Roger* v. *Hutcheson and Greenshields.*—Reference is made to the previous reports of this case in the "*Journal*" of April 1921, p. 223, and October 1921, p. 464.

Judgment was pronounced in the House of Lords on 29th May in the Manorhill arbitration case. An appeal was taken by Thomas Greenshields and Thomas Steel Greenshields against the decision of the Second Division of the Court of Session which recalled the Interlocutor of the Lord Ordinary (Lord Sands) in an action of declarator raised by Harry Stevenson Roger who was outgoing tenant of the farm of Manorhill.

This action was raised by Mr Harry Stevenson Roger, outgoing tenant of the farm of Manorhill, Roxburghshire, to have Mr William Hutcheson, farmer, Courthill, Selkirk, ordained to adjudicate upon a claim in an arbitration in which he was appointed oversman. Mr Roger, the outgoing tenant, renounced his lease of the farm of Manorhill in favour of the proprietor Mr Hugh James Elibank Scott Makdougall, and the farm was thereafter let to Messrs Greenshields who undertook liability for the landlord's obligations to the outgoing tenant with regard to all claims competent to him under the Agricultural Holdings (Scotland) Act, 1908, and any reference in connection therewith. A submission to two arbiters, and an oversman to be appointed by them, was entered into, and after sundry procedure, the arbiters differing, the reference was devolved on the oversman. The oversman issued proposed findings in which he expressed the view that the claim for compensation fell to be decided by a single arbiter in terms of section 11 (1) of the Act. The respondent, Mr Roger, then brought the present action to have it declared that the oversman must proceed to fix the compensation in terms of the submission. In their defences the appellants, Messrs Greenshields, raised the question as to whether timeous notice of the claim for compensation for unexhausted manures, etc., had been lodged.

In the Outer House, Lord Sands found for the defenders, and the pursuer, Mr Roger, reclaimed to the Second Division, which unanimously reversed the judgment of the Lord Ordinary, and decided in favour of the pursuer. The defenders, Messrs Greenshields, appealed to the House of Lords, aad the case was argued before Lords Haldane, Dunedin, Finlay, Cave and Wrenbury, who unanimously dismissed the appeal with costs.

The leading judgment was given by Lord Dunedin, who said :—

> "In the present case, the landlord had taken the incoming tenant bound that he should relieve him of the claim for compensation. That agreement had been made known to the outgoing tenant, and the position accepted by him. There was, therefore, no case of failure on the part of the landlord and his tenant to agree. They were content that the incoming tenant should pay, and that as to the amount the incoming and outgoing tenant should arrange between themselves that that amount should be fixed by arbitration. In effect, the landlord had said : I will agree to give, and the outgoing tenant had said I will agree to take, what the outgoing and incoming tenants would settle as between themselves as the proper sum to be paid. It would have been imperative on the landlord and the outgoing tenant, if they had wished to go to arbitration, to keep within the express provisions of the Act ; but there was nothing illegal in the outgoing and the incoming tenant, who is not brought on the field by the provisions of the Act, but only by the agreement of all the parties concerned, to agree that the sum as between them should be fixed by a common law arbitration. The first point, therefore, failed. As to the second point, it is quite true that the claim for compensation, which the incoming tenant has to pay, must be a claim which the outgoing tenant could have made directly against the landlord under the Act ; and I have no doubt, therefore, that the claim must have been made timeously, and therefore must be judged by section 6 (2) of the Act, which is as follows :—'A claim by the tenant of a holding for compensation under this Act in respect of any improvement comprised in the first schedule to this Act shall not be made after the determination of the tenancy.' But in the circumstances which we have here, I think it is impossible for the incoming tenant to maintain that the claim was not timeously made. That it was to be insisted on as against the landlord was clearly expressed in a letter written to the landlord's agents before the arrangments 'with the outgoing tenant, and is necessarily shown by the fact that the determination of such claim is one of the heads of the submission. All these things had been done before the expiry of the tenancy. The appellants are, therefore, driven to argue that a claim must give particulars, and they laid stress on the fact that in the English Act the expression is 'notice of claim,' while the expression in the Scottish Act is only 'claim.' This is a double-edged argument. It is extremely improbable when hitherto the two countries had been dealt with in one Act, and it was deemed expedient to provide for the new legislation in separate Acts, that the legislature should wish to make a difference between the two countries in such a matter. It is much more likely to suppose that the expressions were regarded as synonymous. I am of the opinion that fair notice is all that is needed to be given. The same argument as to the necessity of giving particulars when the same word 'claim' alone is used was put forward and rejected in the Workmen's Compensation Act. When the matter comes to arbitration of course particulars must be given, but that is a mere matter of procedure. I am, therefore, of opinion that the appeal should be dismissed with costs."

Lords Haldane, Finlay, Cave and Wrenbury concurred.

Waygoing Tenant's Claim for Crop. *Binnie* v. *Bruce.*—In this action, raised in the Sheriff Court at Haddington, Thomas Binnie and Mrs Mary Ann Miller Dryborough or Binnie, formerly tenants of the farm of Seton Mains, in the parish of Tranent, Haddington, sued William Bruce, now proprietor of the said farm, for £65, 4s. 4d., being the value of a crop of oats sown by the pursuers and reaped by the defender. The case which dealt with other matters which are not of general interest was appealed to the Sheriff-Principal (Sheriff Crole), who has now issued his interlocutor, in which he finds that the pursuers have failed to set forth a relevant case as regards the sum of £65, 4s. 4d., and to that extent and effect sustains the defender's first plea-in-law. The facts of the case are set forth in the Sheriff's interlocutor, which is as follows:—

"The pursuers were tenants of the farm of Seton Mains, East Lothian, down to Whitsunday 1919, under a lease from Lord Wemyss. This lease was entered into in 1899 for a period of nineteen years, and was continued by tacit relocation until the first-mentioned date. The pursuer, Thomas Binnie, was also a yearly tenant of a piece of ground of about 3½ acres under a missive of lease from the North British Railway Company. He gave up his tenancy of this piece of land also at Whitsunday 1919. The said piece of land originally formed part of the farm of Seton Mains, and the pursuers have cultivated it as if it still formed part of that farm. The defender purchased the farm of Seton Mains in 1918, and took personal occupation of the farm at Whitsunday 1919. The defender also became tenant of the North British Railway Company of the piece of land above referred to at Whitsunday 1919. When he became tenant, the said piece of land was in white crop, the ground having been prepared and the crop sown by the pursuers prior to Whitsunday 1919. When the crop ripened, the defender reaped and took possession of it. Under the first and main item of the claim the pursuers sue the defender for the value of this crop.

"Counsel for the pursuers maintained that the missive of lease above referred to, which is No. 9 of process, constituted an agricultural lease. Consequently the general rule applied that a waygoing tenant is entitled to reap the crop he has sown, as it was his property. He also maintained that there was a universal custom in this respect in similar cases. He referred to section 62 of the Sale of Goods Act, 1893, as showing that industrial growing crops might be the subject of a contract of sale. There is no dispute as to the custom in farm leases for a term of years that a waygoing tenant is entitled to reap the crop he has sown. A proof on this point therefore seems to be unnecessary. The Sheriff-Substitute has allowed a proof of universal custom in similar cases, and I agree with him that if proof were to be allowed it must be a proof limited as stated by him in his note. Counsel, however, stated that if I was of that opinion he did not desire a proof so limited—I suppose because he was aware it was impossible to establish such a custom in cases similar to the present.

"The pursuers' argument is based on the assumption that the missive of lease before referred to was an agricultural lease. In my opinion it is not. The terms of let under the said missive were that the let was to be a yearly one as from Whitsunday 1899, the railway company having power to resume possession on three months' notice without compensation; the rent was to be payable half yearly; the tenant was to provide fences, and there was to be no sub-letting without consent of the landlords. There is no mention of cultivation or the mode of cultivation, and no clauses characteristic of a farm lease. In my opinion, the pursuers got possession of this piece of ground unconditionally except as stated in the missive. They chose to cultivate it as part of Seton Mains, but need not have done so. They could have used it for any purpose they thought proper, *e.g.* for use as a poultry farm. I therefore think that the argument of the pursuers fails, and I think it unnecessary to deal with the question on the assumption that this was a farm lease."

OFFICIAL ORDERS AND CIRCULARS.

THE following orders dealing with the importation of plants from abroad and the sale of plants attacked by injurious insects or pests have been made by the Board:—

THE DESTRUCTIVE INSECTS AND PESTS (SCOTLAND) ORDER OF 1922 (DATED 23rd JUNE 1922).

Importation of Plants.

The Board of Agriculture for Scotland, by virtue and in exercise of the powers vested in them under the Destructive Insects and Pests Acts, 1877 and 1907, and of every other power enabling them in that behalf, do order, and it is hereby ordered as follows:—

Commencement.

1. This Order shall come into operation on the first day of August, nineteen hundred and twenty-two.

Definitions.

2. In this Order:—"The Board" means the Board of Agriculture for Scotland; "Inspector" means an Inspector of the Board of Agriculture for Scotland; and the expression "plant" shall, where the context permits, include tree and shrub and the fruit, seeds, tubers, bulbs, layers, cuttings or other parts of a plant.

Restriction on Importation of Plants.

3.—(1) The landing in Scotland from any country other than England and Wales, Ireland and the Channel Islands of any of the plants mentioned in the First Schedule to this Order is prohibited except in accordance with the regulations set out in the Third Schedule hereto.

(2) The importer of any plant, the landing of which is regulated by this Article, shall comply with the Regulations set out in the Third Schedule hereto.

(3) This Article shall not apply to any plant the landing of which is authorised by a general licence issued by the Board, or by a special licence issued by an Inspector, or to a consignment of a plant to the Board for experimental or scientific purposes.

Powers of Entry.

4. An Inspector may, upon production if so required of his appointment or authority, enter any premises and examine any plant on such premises which has been landed in Scotland from any country, except as aforesaid or on which he has reason to believe that an insect or pest mentioned in the Second Schedule to this Order exists or has recently existed.

Precautions to be adopted in case of Disease.

5.—(1) An Inspector may at any time and from time to time by a Notice served on the occupier of premises on which he has reason to believe that there is any plant attacked with any insect or pest mentioned in the Second Schedule to this Order require him to adopt such measures for prevention of the spread of the insect or pest as are specified in the Notice.

(2) A Notice under this Article may prescribe the time within which the adoption of any measure thereby prescribed shall be completed.

Power to deal with Living Specimens of Insects or Pests.

6. No person shall land, sell, or offer for sale a living specimen of any insect or pest mentioned in the Second Schedule to this Order, except with the written permission of the Board, and an Inspector may, by a notice served on any person having in his possession or under his charge any such living specimen, require him to adopt such measures for the prevention of the spread of the insect or pest as are specified in the Notice.

Service of Notices, Etc.

7. For the purpose of this Order a Notice shall be deemed to be served on any person if it is delivered to him personally or left for him at his last

known place of abode or business, or sent through the post in a letter addressed to him there; and a Notice purporting to be signed by an Inspector shall be *primâ facie* evidence that it was signed by him.

Information to be given as to Diseased Plants or parts thereof.

8. Every person who has or has had in his possession or under his charge any plant which is attacked by any insect or pest mentioned in the Second Schedule to this Order, and every person who as auctioneer, salesman or otherwise has sold or offered for sale any such plant shall, if so required in writing by the Board or an Inspector, give to the Board or Inspector all such information as he possesses as to the persons in whose possession or under whose charge the plant is or has been; provided that any information given under this Article shall not be available as evidence against the person giving the same in any prosecution under this Order, except in respect of an alleged failure to comply with this Article.

Offences.

9.—(1) Every person shall be liable on conviction to a penalty not exceeding ten pounds who does any act in contravention of this Order or the Regulations in the Third Schedule to this Order or any notice served on him under this Order, or fails to do any act which he is required to do by this Order or the said Regulations or any such Notice.

(2) This Article does not apply to the landing or attempted landing of anything in contravention of this Order, the penalty for which is provided by section one of the Destructive Insects Act, 1877, as amended by the Destructive Insects and Pests Act, 1907.

Revocation of Order.

10. The Destructive Insects and Pests Order of 1910 (in so far as it applied to Scotland) and Article 9 of the American Gooseberry Mildew (Scotland) Order of 1920 are hereby revoked.

Application of the Order.

11. This Order shall apply to Scotland.

Short Title.

12. This Order may be cited as the DESTRUCTIVE INSECTS AND PESTS (SCOTLAND) ORDER OF 1922.

In witness whereof the Official Seal of the Board of Agriculture for Scotland is hereunto affixed this twenty-third day of June nineteen hundred and twenty-two.

L. S.

CHAS. WEATHERILL,
Secretary.

FIRST SCHEDULE.

(*a*) All living plants with a persistent woody stem above ground, and parts of the same, except seeds, when for use in propagation—such as fruit trees, stocks and stools, forest trees, and ornamental shrubs and grafts, layers and cuttings thereof.

(*b*) All potatoes; and all tubers, bulbs, rhizomes, corms, and hop stocks for planting

(*c*) Seeds of onions and of leeks for sowing.

(*d*) Gooseberries.

SECOND SCHEDULE.

Fungi.

Black Knot of Plum and Cherry (*Plowrightia morbosa*, Sacc.).
Fire or Pear Blight (*Bacillus amylovorus*, Trev.).
Chestnut Canker (*Endothia parasitica* (Murr.), Ander. & Ander.).

Wart Disease or Black Scab of Potatoes (*Synchytrium endobioticum*, Perc.).

Onion and Leek Smut (*Urocystis cepulae*, Frost).

Downy Mildew of Hops (*Peronoplasmopara humuli*, Miy. et Taka.).

Insects.

Vine Louse (*Phylloxera vastatrix*, Planch.).

American Apple Capsids (*Heterocordylus malinus*, Reut., and *Lygidea mendax*, Reut.).

Pear Tingid (*Stephanitis pyri*, Fab.).

Colorado Beetle (*Leptinotarsa decemlineata*, Say.).

Plum Curculio (*Conotrachelus nenuphar*, Herbst.).

Potato Moth (*Phthorimaea operculella*, Zell.).

American Lackey Moths (*Malacosoma americana*, Fab., and *M. disstria*, Hubn.).

Oriental Fruit Moth (*Cydia molesta*, Busck.).

San José Scale (*Aspidiotus perniciosus*, Comst.).

Japanese Fruit Scale (*Diaspis pentagona*, Newst.).

Apple Fruit Fly (*Rhagoletis pomonella*, Welsh).

Cherry Fruit Flies (*Rhagoletis cerasi*, Linn., *R. cingulata*, Loew., and *R. fausta*, Osten Saken).

Gooseberry Fruit Fly (*Epochra canadensis*, Loew.).

THIRD SCHEDULE.

Regulations Governing the Importation of Plants into Scotland.

1. The restrictions on landing imposed by the Order and these Regulations do not apply to plants, the landing of which is authorised by a general licence issued by the Board, or by a special licence issued by an Inspector, or to consignments of plants to the Board for experimental or scientific purposes.

Inspection and Certification as a Condition of Entry.

2. (*a*) In the case of an importation of plants, otherwise than through the post, from a country whose service of plant inspection is recognised for the time being, each consignment must be accompanied by two copies of a certificate issued after inspection, and not more than fourteen days prior to the date of shipment, by a duly authorised official of the country whence the plants are exported, in the form prescribed below. One copy of the certificate must be produced to the Customs Officer at the port of entry, and the other copy must be forwarded by the importer to the consignee. In the case of consignments imported through the post, a copy of the prescribed certificate need not be produced to the Customs Officer, but a copy must be affixed to each package.

The original of the certificate must be forwarded by post, before the plants are despatched, by the Exporter to the Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

Certificate of Examination of Plants, No. .

This is to certify that the plants included in the package or consignment described below were thoroughly inspected by , a duly authorised official of , on , and were found or believed by him to be healthy and free from any of the plant diseases or pests named in the Second Schedule to the Destructive Insects and Pests (Scotland) Order of 1922.

This additional certificate must be given for all potatoes:—

Further, it is hereby certified that no case of the disease known as Wart Disease or Black Scab of Potatoes (*Synchytrium endobioticum*) has occurred on the farm or holding where the potatoes included in this consignment were grown nor within 500 yards (approximately ½ kilometre) thereof.

(Signed)..

(Official Status)..

The following details must be filled in by the Shipper :—

Number and Description of Packages in Consignment..
Distinguishing Marks..
Description of Plants.. ....
Grown at..
Name and Address of Exporter....................................
Name and Address of Consignee..................................
Name of Vessel..
Date of Shipment...
Port of Shipment...
Port of Landing in Scotland.......................................
Approximate Date of Landing.....................................
(Signed).....................................

An Inspector of the Board of Agriculture for Scotland may open and examine the contents of any consignment or package imported or believed to have been imported into Scotland, notwithstanding the fact that the consignment may be accompanied by, or the package may have attached thereto, the duly authorised copy certificate.

(*b*) In the case of an importation of plants from a country where no recognised service of plant inspection is maintained, and in the case of a consignment of plants which is not accompanied by copy certificates as above mentioned, or of a package of plants imported through the post to which a copy certificate is not attached, the plants shall be retained by the importer or consignee until they have been examined by an Inspector of the Board of Agriculture for Scotland at a suitable place designated by the Inspector or by the Board, and certified in writing to be healthy and free from the insects and pests mentioned in the Second Schedule to this Order, or until their removal has been authorised in writing by the Board or by an Inspector of the Board.

(*c*) Any imported plants which on inspection are found to be unhealthy or attacked by any insect or pest mentioned in the Second Schedule to this Order, and which, in the judgment of the Inspector, cannot be cleaned by disinfection or other treatment, shall, with the packing and package, either be destroyed or returned to the country of exportation by the importer thereof.

(*d*) When disinfection or other treatment of the plants is allowed, it shall be carried out by the importer, and under the supervision of an Inspector of the Board of Agriculture for Scotland, at a suitable place designated by the Inspector or the Board, and no part of the consignment shall be moved from the place designated without the written consent of the Inspector.

(*e*) The Board's charge for the services of the Inspector and all charges for storage, cartage and labour incident to inspection and disinfection, shall be paid by the importer.

3. Plants will not be deemed to be healthy which are attacked by any insect or pest mentioned in the Schedule and the Note to the Sale of Diseased Plants (Scotland) Order of 1922.

THE SALE OF DISEASED PLANTS (SCOTLAND) ORDER OF 1922 (DATED 23rd JUNE 1922).

Sale of Diseased Plants.

The Board of Agriculture for Scotland, by virtue and in exercise of the powers vested in them under the Destructive Insects and Pests Acts, 1877 and 1907, and of every other power enabling them in that behalf, do order, and it is hereby ordered as follows :—

Definitions.

1. In this Order :—"The Board" means the Board of Agriculture for Scotland : and "Inspector" means an Inspector of the Board of Agriculture for Scotland.

The expression "Local Authority" means as regards any district the local authority for the district under the Diseases of Animals Acts, 1894 to 1914.

The expression "plant" shall include tree and shrub and the seeds, tubers, bulbs, layers, cutting or any other parts of a plant.

Prohibition of Sale of Diseased Plants, etc.

2. No person shall sell, offer or expose for sale or cause to be sold, offered or exposed for sale for planting, any plant substantially attacked by any insect or pest mentioned in the Schedule to this Order.

Information to be given as to Diseased Plants.

3. Every person who has or has had in his possession or under his charge, and every person who as auctioneer, salesman, nurseryman or otherwise has had in his possession for sale or has sold, offered or exposed for sale, any plant substantially attacked by any insect or pest mentioned in the Schedule to this Order, shall, if so required in writing by the Board or by an Inspector, give the Board or Inspector, as the case may be, all such information as he possesses as to the person in whose possession or under whose charge such plant is or has been: provided that any information given under this Article shall not be available as evidence against the person giving the same in any prosecution under this Order, except in respect of an alleged failure to comply with this Article.

Powers of Entry.

4. An Inspector may, upon production if so required of his appointment or authority, enter any premises on which he has reason to believe that an insect or pest mentioned in the Schedule to this Order exists or has recently existed, and examine any plant on such premises.

Action to be taken to prevent Sale or Movement of Diseased Plants.

5. Any auctioneer, salesman, nurseryman, or other person, on becoming acquainted or being informed by an Inspector that he has in his possession or under his charge any plant substantially attacked by an insect or pest mentioned in the Schedule to this Order, shall take steps to prevent the sale or movement of such plant except under the authority of an Inspector.

Power of Inspector to order Destruction or Disinfection.

6.—(1) An Inspector may at any time by notice served on any person who as auctioneer, salesman, nurseryman or otherwise has in his possession for sale, or who offers or exposes for sale or causes to be offered or exposed for sale for planting any plant which is substantially attacked by an insect or pest mentioned in the Schedule to this Order, require him to adopt such measures as are authorised by this Article and specified in the notice.

(2) A notice under this Article may require the auctioneer, salesman, nurseryman or other person named in the notice to adopt one or more of the following measures, that is to say:—

(*a*) To destroy the whole or any part of the plant by fire or such other suitable method as may be specified in the notice;

(*b*) To disinfect the plant to the satisfaction of the Inspector;

(*c*) To take such other steps as the Inspector may consider necessary to prevent the spread of disease.

(3) Any such notice may appoint the time within which the adoption of any measure thereby prescribed shall be completed.

Service of Notices, etc.

7. For the purpose of this Order a notice shall be deemed to be served on any person if it is delivered to him personally or left for him at his last known place of abode or business, or sent through the post in a letter addressed to him there; and a notice purporting to be signed by an Inspector shall be *primâ facie* evidence that it was signed by him as an Inspector.

Penalties.

8. Every person shall be liable on conviction to a penalty not exceeding ten pounds, who—

(1) Sells, offers or exposes for sale or causes to be sold, offered or exposed for sale for planting any plant substantially attacked by any insect or pest mentioned in the Schedule to this Order; or

(2) Fails to take such steps as are required under Articles 5 and 6 of this Order; or fails to give information as required by Article 3; or

(3) Wilfully obstructs or impedes any Inspector when acting under this Order.

Notification of Order.

9. This Order shall be published by the Local Authority in accordance with any direction given by the Board.

Revocation of Order.

10. The Corky Scab of Potatoes (Scotland) Order of 1914 is hereby revoked.

Application of the Order.

11. This Order shall apply to Scotland.

Short Title.

12. This Order may be cited as the Sale of Diseased Plants (Scotland) Order of 1922.

Commencement of Order.

13. This Order shall come into operation on the first day of August 1922.

In witness whereof the Official Seal of the Board of Agriculture for Scotland is hereunto affixed this twenty-third day of June nineteen hundred and twenty-two.

L. S.

CHAS. WEATHERILL,
Secretary.

SCHEDULE.

A. *Fruit and other Tree Pests.*

Fruit Tree Cankers (produced by *Nectria ditissima*, Tul., or any species of *Monilia*).
Silver Leaf (*Stereum purpureum*, Pers.).
Black Currant Mite (*Eriophyes ribis*, Nal.).
Woolly Aphis (*Eriosoma lanigerum*, Hausm.).
All Scale Insects (*Coccidæ*).
Brown Tail Moth (*Nygmia Phæorrhæa*, Dan.). (*Euproctis chrysorrhæa.*)
Rhododendron Fly (*Leptobyrsa* (*Stephanitis*) *rhododendri*, Horv.).

B. *Vegetable and Root Pest.*

Corky or Powdery Scab of Potatoes (*Spongospora subterranea*, Lagerh.).
Onion and Leek Smut (*Urocystis cepulæ*, Frost).

Note.

The sale of plants, etc., attacked by—

American Gooseberry Mildew (*Sphærotheca morsuvae*, Berk, or
Wart Disease of Potatoes (*Synchytrium endobioticum*, Perc.),

is dealt with under the following Orders respectively:—

American Gooseberry Mildew (Scotland) Order of 1920.
Wart Disease of Potatoes (Scotland) Order of 1918.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in March, April and May, 1922.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	MARCH.			APRIL.			MAY.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK :—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	68 6	62 3	46 3	69 0	63 0	45 7	75 10	68 5	49 1
Shorthorn	64 7	60 7	51 2	66 0	62 6	48 3	71 10	68 5	47 7
Galloway	62 0	57 11	53 0	67 4	61 9	38 6	72 3	62 6	..
Ayrshire	68 0	56 10	22 0	64 0	56 6	25 9	67 7	54 0	37 7
Cross-bred	65 4	58 8	43 6	66 1	60 2	43 11	72 7	66 0	47 5
Blue Grey	...	...	...	...	...	...	80 2	66 4	. .
Highland	60 0	57 0	...	...	...	...	...	...	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES	...	11½	8½	20	10¼	6¾	20¼	11	6
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.
Cheviot	18	16¾	14½	20¾	19¾	16¾	23	21¾	17¾
Half-bred	17¾	16¾	15¼	20¼	19	16¼	21¾	20½	17½
Blackface	17	15½	13¾	19½	18½	16	21¾	20	16½
Greyface	17¾	16¼	14	20	18¾	15¾	21¾	20	16¼
Down Crosses ..	17½	16½	...	20½	19½	...	22¼	21	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	13 8	12 2	10 8	13 9	11 11	10 4	14 3	12 6	12 0
Porkers	14 1	12 8	10 10	14 1	12 5	10 6	14 5	13 4	12 0

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	MARCH.			APRIL.			MAY.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
STORE STOCK :—									
STORE CATTLE—	per head.	per head.	per head.	per head.	per head.	per head.	per head.	per head.	per head.
Aberdeen-Angus :	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*	£ *s.*
Yearlings	21 11	17 0	13 7	22 2	16 14	12 16	21 15	17 12	12 12
Two-year-olds ...	28 12	23 16	19 0	30 10	24 10	20 1	30 5	25 6	20 17
Shorthorn :									
Yearlings	...	...	...	...	...	...	16 10	12 15	8 0
Two-year-olds ...	...	...	...	...	...	..	23 5	21 0	17 0
Galloway:									
Yearlings	...	...	...	15 17	9 17	...	17 0	13 5	...
Two-year-olds ...	23 0	18 15	...	25 18	19 1	...	32 15	25 0	...
Ayrshire :									
Yearlings	...	...	...	13 13	7 2	7 0	12 2	8 10	..
Two-year-olds ...	...	...	.	...	...	...	20 9	14 0	...
Cross-bred :									
Yearlings	19 13	15 16	12 14	19 2	15 12	12 5	19 10	15 18	11 19
Two-year-olds ...	27 3	22 10	18 5	26 4	21 19	18 0	28 18	24 4	20 9
Blue Grey :									
Yearlings	...	...	...	...	...	..	22 0	15 7	...
Two-year-olds ...	...	...	...	.	...	...	...	...	...
Highland :									
Yearlings	...	...	..	...	..	...	12 3	10 0	8 5
Two year-olds ...	...	...	...	...	...	..	18 9	15 15	13 12
Three-year-olds ...	...	...	...	...	...	...	26 15	25 2	21 3
DAIRY COWS—									
Ayrshire :									
In Milk	...	..	...	31 8	24 15	12 0	38 7	26 13	13 4
Calvers	33 5	26 3	15 5	29 14	24 11	13 18	39 0	27 12	16 1
Shorthorn Crosses :									
In Milk	40 0	29 0	20 12	41 0	31 8	21 0	40 10	31 7	23 3
Calvers	41 14	29 19	19 13	38 5	27 5	18 2	39 8	27 3	17 13
STORE SHEEP—	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s* *d.*	*s.* *d.*	*s.* *d.*
Cheviot Hoggs ...	63 5	52 10	36 0	57 7	44 6	31 10	67 7	52 10	40 7
Half-bred Hoggs ...	81 0	68 1	55 0	83 10	70 9	62 0	93 1	76 6	63 2
Blackface Hoggs ...	54 6	29 2	...	42 4	34 0	26 0	51 4	36 9	28 11
Greyface Hoggs ..	65 11	56 7	46 4	66 9	56 6	49 10	74 3	63 4	49 4
STORE PIGS—									
(6 to 10 weeks old)	45 0	28 4	...	60 6	39 6	...	55 5	39 1	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	March.			April.			May.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF :—		per lb. *d.*	per lb. *d.*	per lb *d.*	per lb. *d.*	per lb *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
Home-fed—										
Bullock or Heifer ...	1	10¼	11⅛	11⅝	10	10⅞	12	11⅝	12⅝	13
	2	9⅝	9¼	10¼	9	9⅝	10⅜	10¼	10⅞	11
Bull	1	8⅜	9	8½	8	9⅜	8¾	9⅛	10⅛	9¾
	2	7¾	8¼	7⅝	7	8⅝	7¼	8¼	9⅛	7⅞
Cow	1	6½	7½	8	6¾	7½	8½	8¼	7¾	9⅛
	2	6	6⅛	6⅜	6⅛	6⅜	6⅞	7⅝	6½	7⅜
Irish—										
Bullock or Heifer ...	1	...	...	10¼	...	...	10⅜	...	-	11⅝
	2	...	...	9¼	...	..	9⅝	...	..	9⅞
Bull	1	...	...	7¾	...	...	8	...	...	8¾
	2	...	...	7	...	...	6½	...	...	7
United States and Canadian—										
Killed at Glasgow ...	1	..	..	9½	...	...	10½	...	..	12
	2	...	...	...	..	...	10	...	...	10½
Argentine Frozen—										
Hind Quarters ...	1	...	5½	5⅛	...	5⅝	5⅝	...	5½	5¾
Fore ,, ...	1	...	4	3⅞	...	4⅛	4⅛	...	4¼	4¼
	2	..	..	3⅝	...	...	3⅝	...	...	3½
Argentine Chilled—										
Hind Quarters ...	1	...	6⅜	6½	...	8⅛	8¼	...	7¾	8
	2	...	...	6⅜	...	...	7½	...	...	7⅛
Fore ,, ...	1	...	4⅛	4⅛	..	4⅜	4¾	...	4⅜	4⅜
	2	...	...	3⅞	...	..	4⅜	...	...	3⅞
New Zealand Frozen—										
Hind Quarters ...	1	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	...	3¼	...	...	3¾	..	...	3¾
	2	...	...	3⅛	...	...	3½	...	...	3½
Australian Frozen—										
Hind Quarters ...	1	...	..	4½	...	...	..	..	...	...
Fore ,, ...	1	...	...	...	..	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	15⅛	16⅜	17	18¾	19⅛	19⅛	20¾	21	20⅞
	60 lb. and over.	...	15¾	15	17½	18½	18⅜	19¾	20⅛	19¾
,, Cross	under 60 lb.	15⅜	16⅞	17	18¾	19⅝	19⅛	20¾	21½	20⅞
	60 lb. and over.	..	16¼	15	17½	18⅞	18⅜	19¾	20½	19⅝
Ewes, Cheviot ...	1	12	13⅝	15	14¾	16¾	15⅞	18¼	16½	18⅛
	2	11	...	14⅜	13¾	...	14⅞	17	...	16
,, Blackface ...	1	12¾	...	15	14¾	...	15⅞	18¼	...	18⅛
	2	11¾	...	14¼	13¾	.	14⅞	17	...	15¾
,, Cross	1	12	12½	15	13½	15⅞	15⅞	16¼	15	17
	2	11	...	14¼	12	...	14¾	15½	...	14¾
Argentine Frozen ...	1	...	8	7⅜	..	8	7½	...	7¾	7¾
	2	...	..	7	...	...	7	...	7⅜	6½
Australian ,, ...	1	..	...	7¼	...	...	7¼	...	8⅜	7¼
	2	...	...	7	...	..	...	...	...	6
LAMB :—										
Home-Fed	1	..	...	..	...	...	...	...	21	...
New Zealand Frozen	1	...	11⅝	11¼	...	11⅜	12⅜	...	12¾	12⅞
	2	...	10⅜	...	...	10¼	...	...	...	11½
Argentine ,, ...	1	...	...	...	...	-	...	...	10⅜	...
Australian ,, ...	1	...	...	9¾	...	...	11⅜	...	...	11¾
	2	...	...	9½	...	...	9½	...	...	10

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	March.		April.		May.	
		s.	*d.*	*s.*	*d.*	*s.*	*d.*
BUTTER:							
Irish Creamery ... per cwt.	1	176	0	176	6	176	10
	2	...		...		...	
,, ,, (Unsalted) ,,	1	180	0	181	6	182	10
Canadian ... ... ,,	1	...		...		...	
,, (Unsalted) ,,	1	...		...		...	
Danish ... ... ,,	1	179	7	196	0	184	5
,, (Unsalted) ,,	1	...		...		186	0
Australian ... ... ,,	1	144	0	180	6	172	10
,, (Unsalted) ,,	1	151	7	181	6	175	2
New Zealand ... ... ,,	1	156	5	189	0	180	5
,, (Unsalted) ,,	1	160	10	191	0	180	10
Argentine ... ... ,,	1	116	0	175	6	168	10
,, (Unsalted) ,,	1	137	10	178	6	174	10
CHEESE:							
Cheddar ... ... ,,	1	112	10	110	0	72	10
	2	101	2	98	0	70	0
Cheddar Loaf ... ... ,,	1	122	5	120	0	90	0
	2	113	7	112	0	...	
Dunlop ... ... ,,	1	107	2	103	0	72	10
	2	96	5	94	0	70	0
Canadian ... ... ,,	1	102	5	101	0	88	0
	2	98	10	99	0	84	10
New Zealand ... ... ,,	1	98	10	99	0	89	2
	2	90	0	96	0	80	10
BACON:							
Ayrshire (Rolled) ... ,,	1	164	0	170	6	186	5
Irish (Green) ... ... ,,	1	143	2	146	9	170	2
,, (Dried or Smoked) ,,	1	108	10	165	0	187	10
,, (Long Clear) ... ,,	1	149	0	147	6	170	0
Wiltshire (Green) ... ,,	1	143	2	140	9	170	2
,, (Dried or Smoked) ,,	1	162	10	166	6	187	10
American, Long Clear Middles (Green) ,,	1	114	10	109	0	116	0
BACON (*continued*):							
American, Short Clear Backs ... ... per cwt.	1	95	7	92	0	90	0
American Bellies ... ,,	1	91	2	90	0	86	0
,, Sides ... ,,	1	105	7	104	0	106	0
,, Cumberland Cut ,,	1	104	5	104	0	106	0
Canadian, Sides ... ,,	1	121	0	118	9	134	0
Danish, Sides ... ,,	1	134	5	130	0	157	2
HAMS:							
Irish Smoked ... ,,	1	190	0	194	6	245	0
	2	185	0	187	6	236	0
American, Long Cut (Green) ... ... ,,	1	126	5	128	9	137	7
	2	123	7	124	6	133	0
American Short Cut ,,	1	126	0	127	9	116	5
	2	122	10	125	0	132	10
Canadian, Long Cut ,,	1	128	0	132	0	...	
	2	125	0	125	0	...	
EGGS:							
Country ... ... per doz.	1	1	10	1	8	1	7
	2	1	8	1	6	1	5
Irish ... ... per 120	1	17	11	14	9	13	8
	2	17	1	14	0	13	1
,, (Duck) ... ,,	1	23	0	17	9	15	5
	2	20	0	17	6	...	
Danish ... ... ,,	1	21	3	16	6	15	11
	2	19	3	15	6	14	2
Dutch (Duck) ... ,,	1	...		17	0	16	0
Egyptian ... ... ,,	1	11	7	9	11	10	3
Hungarian ... ,,	1	...		...		12	0
Polish ... ... ,,	1	...		...		11	6
Styrian ... ... ,,	1	...		...		13	6

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Markets.	Quality.	Second Earlies.	Late Varieties.			
			Red Soils.		Other Soils.	
			Lang-worthy.	Other.	Lang-worthy.	Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
		MARCH.				
Dundee	First ...	...	...	...	...	6 8 0
	Second ...	...	...	...	...	...
Edinburgh	First ...	...	...	...	11 0 0	6 10 0
	Second ...	...	...	...	...	...
Glasgow	First ...	...	11 0 0	10 0 0	...	6 14 7
	Second ...	...	...	...	...	...
		APRIL.				
Dundee	First ...	...	...	...	...	6 13 9
	Second ...	...	...	...	...	...
Edinburgh	First ...	...	...	...	...	7 12 6
	Second ...	...	...	...	...	...
Glasgow	First ...	...	...	11 15 0	...	7 0 9
	Second ...	...	...	...	...	...
		MAY.				
Dundee	First ...	...	...	...	...	9 8 0
	Second ...	...	...	...	...	...
Edinburgh	First ...	...	...	...	...	11 13 9
	Second ...	...	...	...	...	...
Glasgow	First ...	...	...	13 14 0	...	10 0 0
	Second ...	...	...	...	...	...

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Markets.	Quality.	Roots.			Hay.		Straw.			Moss Litter.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Barley.	Oat.	
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.
		MARCH.								
Dundee ...	1	...	17 0	15 7	148 0*	...	87 6*	...	93 0*	...
	2	...	...	...	140 0*	...	...	...	...	...
Edinburgh	1	...	...	13 0	131 0†	...	65 6†	54 0†	71 6†	...
	2	...	...	...	88 4†	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	33 6
		APRIL.								
Dundee ...	1	...	...	20 3	152 6*	150 0*	86 11*	...	88 2*	...
	2	...	...	...	...	...	...	...	...	...
Edinburgh	1	...	...	...	130 8†	...	68 2†	58 9†	79 5†	...
	2	...	...	...	...	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	31 3
		MAY.								
Dundee ...	1	...	...	39 0	194 0*	...	93 0*	92 6*	93 0*	...
	2	...	...	32 8	...	...	...	...	...	...
Edinburgh	1	...	...	...	182 0†	180 0†	71 6†	60 0†	83 6†	..
	2	...	...	...	125 0†	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	30 0

* Price for Hay and Straw baled and delivered.

† Price for Hay and Straw delivered loose in town.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	March.		April.		May.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
*Home	17 1 0	16 6 6	15 3 9	14 13 9	15 9 0	14 13 6
Foreign	16 8 4	...	14 13 9	...	14 19 0	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)	8 11 0	8 0 6	8 0 0	7 8 9	7 13 9	7 2 6
Egyptian (Home-manufactured)	9 18 0	...	9 1 3	...	9 0 0	...
Groundnut Cake	...	...	10 15 0	...	10 1 0	9 17 6
*Palmnut Kernel Cake	...	8 10 0	...	8 10 0	...	8 10 0
Bean Meal ...	13 8 0	12 10 0	12 12 6	13 5 0	13 6 0	13 10 0
Maize	‡8 8 0	8 15 0	‡8 3 2	8 15 0	‡8 7 0	8 13 0
Maize Meal ...	9 11 0	9 15 0	9 1 3	9 15 0	9 7 0	9 13 0
Maize Gluten Feed (Paisley)	9 7 0	...	8 16 3	...	8 11 0	...
Maize Germ Meal	...	11 10 0	...	11 10 0	...	11 10 0
Maize Germ Cake *Meal	12 14 0	...	11 6 4	...	10 15 0	...
Rice Meal... ...	8 2 6	...	...	...	...	...
Locust Bean Meal	...	8 0 0	...	8 0 0	...	8 0 0
Maize Germ Cake	12 0 0	...	10 17 6	...	10 5 0	...
Barley (Feeding) ...	10 18 9	9 0 0	10 10 0	9 0 0	10 19 0	9 8 0
Oats, Canadian ...	11 1 0	...	10 12 6	...	10 10 0	...
„ Home ...	10 11 3	9 0 0	10 6 11	9 0 0	11 7 6	9 19 0
*Malt Culms	7 2 0	6 10 0	6 10 0	6 10 0	5 12 0	6 10 0
Distillery Malt Grains—Dried...	9 17 6	...	9 15 0	...	9 1 8	...
Distillery Mixed Grains—						
Dried	10 0 0	9 0 0	9 5 0	9 0 0	9 5 0	8 18 0
Wet	...	1 15 0	...	1 15 0	...	1 15 0
Brewers' Grains—						
Dried	9 10 0	...	9 12 6	...	...	...
Wet	...	1 15 0	...	1 15 0	...	1 15 0
Wheat—						
†Middlings (Fine Thirds or Parings)	9 8 0	8 18 0	8 16 3	8 2 6	9 2 0	8 9 0
Sharps (Common Thirds)	9 0 0	...	8 1 3	...	8 0 0	...
†Bran (Medium) ...	8 19 0	8 15 0	8 1 11	8 0 0	8 5 0	8 4 0
Feeding Treacle ...	7 6 3	7 10 0	6 15 0	7 10 0	5 18 0	7 4 0
Crushed Linseed ...	...	28 0 0	...	28 0 0	...	28 0 0
Fish Meal... ...	15 10 0	15 10 0	15 10 0	15 10 0	15 8 0	15 10 0

* Price of bags and authorised transport charges are not included.
† Price of sacks included. ‡ American corn.

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ARABLE FARMING IN SCOTLAND.

CHRISTOPHER TURNOR.

I HAVE acceded to the request to write an article for the *Scottish Journal of Agriculture* with feelings of much diffidence.

In the first place, living as I do some hundreds of miles south of the Border, agricultural conditions are very different from those prevailing in the north.

In the second place, although I know Scotland fairly well, it is chiefly from the point of view of one who has spent many delightful holidays in a country which draws all men to it. I will not pretend for one moment that it is agriculture that has been the attraction. At the same time, I have visited a certain number of Scottish farms and I have been much impressed with their excellent cultivation and the general organisation of labour and work on the farm. Then, too, some splendid demonstrations of small holdings are to be seen especially in the south-west of Scotland; which, judged on the points of economy and efficiency of equipment and the satisfactory results achieved by the smallholders, fairly give the lead to the rest of Great Britain.

Finally, we all know that whatever part of the Empire we may visit, there we find the Scotsman more than holding his own; also, that during the great agricultural depression Scottish farmers came down to English counties and took over farms and made a living where English farmers had given up.

In spite of all this, I will make a few criticisms and suggestions in regard to agriculture in Scotland, as the result of a good many years of observation if not of close study, in the hope that these may give rise to discussion out of which something practical may result.

In Scotland, as in England, only even more pronounced, there is the difference between the areas with heavy and with light rainfall. Considering first those parts in which the rainfall is heavy, one is struck by the splendid potato crops invariably seen even in the glens far up into the Highlands. Conversely one realises more and more how unsatisfactory is the oat crop and the attempt to make hay, especially in a wet and sunless season such as the present one. If I am right in supposing that the potato crop, where intelligently managed and sprayed, is by far the most reliable crop that can be grown, it is hard to see why a much greater area is not grown, replacing to a certain extent turnips which have a low trading value in a wet climate. If potatoes are used as raw material the residue is valuable cattle food, and in this form the potato could also replace part of the oat crop. One reason, I think, why the output of potatoes is not much greater in Great Britain than it is, is that we limit the supply more or less to meet the "table" demand. Before the war, Germany, where the cost of producing potatoes differed little from the British cost of production, produced fifty million tons of potatoes against the six million tons produced in the United Kingdom, yet the German consumption of the potato as a table vegetable was only ten million tons per annum. The other forty million tons were used as raw material in a wide range of manufactured commodities—providing valuable subsidiary industries to agriculture. And it is precisely in subsidiary industries beneficial to agriculture that we have lagged so far behind. In many parts of Scotland, especially those with heavy rainfall, there seems to be great need for improved methods of conserving the food produced from the soil. I know that in many districts there are long and steep roads to the railways and high freights, making haulage prohibitively dear; but, on the other hand, there are often unusual facilities for transport by water and many roads are now suitable for motor transport. In suitable centres potato-drying plants, distilleries, starch-making plants might be established; the capital expenditure for these plants is not, I understand, very great. The potato "chips" returned from the distillery and from starch-making are excellent food for stock. The drying of the potato obviates the need for the wasteful pit or clamp, and saves greatly on the cost of transport—for one ton of potatoes from the pit is chiefly composed of water and it is uneconomic to transport water at the present railway rates. Already silos are beginning to appear upon the west coast farms; and if, instead of attempting to harvest hay and oats in wet districts, they were put into the silo, I think it would be far more economic than the present treatment. Magnificent crops of green oats are grown on the west coast: if some beans, peas or tares were grown with them and all put into the silo, much subsequent difficulty would be avoided, and a first-class cattle food would be secured.[1]

So many of our farmers regard hay as an essential food for cattle, but it is not; for years I have not given hay to my cows—only straw. Taking the bulky cattle foods grown upon the farm, a balance has to be kept between the "dry roughness," *i.e.*, straw or hay and "wet roughness," *i.e.*, roots and silage: if the oat crop is turned into silage then the "dry roughness" would be supplied by the potato chips and perhaps a limited quantity of straw.

I am aware that to put up silos of a permanent type and plants for dealing with potatoes would require a considerable expenditure of capital. But for the development of so vital an industry as agriculture, capital should be forthcoming; and if this cannot be obtained without some intervention on the part of the government, then it should intervene. The money advanced would be in the form of a loan, to be repaid by means of an annual sinking fund within a definite period—say of twenty years.

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[1] *See* note on Ensilage, p. 416.

Potato plants might well be put up by groups of farmers co-operatively, the government guaranteeing the interest on the capital invested. This would make it an attractive investment to the ordinary investor. Such a system, by which the government guarantees interest rather than makes a grant or loan, has not often been resorted to in this country, although it is the course that has been adopted by other governments—notably the Belgian—with marked success. Another development in cropping that might well repay experiment is the Harper Adams College system of continuous soiling crops; moisture and a comparatively mild winter are necessary to obtain the best results from this system. The value, to my mind, of these crops is that they increase the range of plants than can be grown on arable land. We must maintain and increase the area under the plough in Great Britain; but if it does not pay to grow corn, or the climate and soil are not suitable, then let other crops be grown on the arable land. So long as the requisite area of plough-land is kept, the needed number of cultivators will be kept on the land; and if, in time of war, it becomes necessary to concentrate largely on the growing of farinaceous food, the plough-land and the labour will be there to produce it.

Coming to the drier parts of Scotland, I would like to see a considerable area under lucerne, if this is possible, and I believe it should be possible. The main varieties of lucerne (*Alphalfa*) seed that we use in England are the Hungarian, Provence and Canadian; but there are some 360 varieties of lucerne—and I am by no means satisfied that we have found the variety that suits us best. Out of so large a number of varieties it seems probable that one or more, such as the hardy "Grims" variety used in the north-west of Canada, ought to suit Scottish conditions; and the plant is so valuable that it would repay exhaustive experiment. In Britain, where lucerne is grown at all, it is regarded as a more or less useful subsidiary crop—as an adjunct to grass, as good food in particular for horses or as useful for feeding to sheep. This is altogether the wrong point of view; lucerne should be looked upon as one of the most important of arable crops, and it should be considered a substitute for cake. Especially in these days of dear cake, it is a good plan for the farm to grow its own cake.

I had a seventeen acre field that for five consecutive years provided all the food consumed by sixty cows, twenty young beasts, two bulls and eight horses, for three months in the summer. During that time the stock received no cake whatever. The field was by no means a good one and would let at about 16s. per acre. But the effect of five years of lucerne upon the field itself was remarkable. After ploughing it up a heavy crop of mangolds was obtained, followed by four consecutive corn crops of which the last one, oats, threshed out at over nine quarters to the acre—an altogether unusual yield for the neighbourhood.

Used as dry food in winter, lucerne again saves the cake; in fact, I consider that my use of lucerne halves my cake bill. I have grown lucerne for twenty years and altogether on a good many hundred acres; and in my part of England, it has certainly proved a most reliable crop, yielding its abundance in wet and in dry summers alike. I have, at this moment, a splendid field of lucerne in its eighth year: it is a thoroughly economic crop, however, if it lasts only five years. Even if lucerne does not come up to expectation in Scotland, there is the range of fodder crops already mentioned which are suitable for dry as well as wet districts. Any such cropping would naturally involve the development of dairying on arable land, and with poor prices for corn and meat I regard arable dairying as about the most profitable combination possible. The object must be to grow sufficient albuminous foods, tares, beans, mixed corn, etc., to replace as far as possible the consumption of bought cake, and at the same time to keep up the fertility of the soil.

Leaving the question of the cropping of the land and coming to the question of the organisation of the industry, it is always a mystery to me why there is not a much greater degree of co-operation amongst farmers in Great Britain than exists to-day. One would have expected the high level of education that prevails among the Scots farmers, to have led them to appreciate the all round advantages of co-operation.

In New Zealand, where the Scottish agriculturist preponderates, there is undoubtedly the most complete system of co-operative societies to be found in any English-speaking country. Then why not in Scotland?

Finally, there is one further development that would, I am convinced, greatly benefit English agriculture, and at the same time provide valuable openings for capable young Scotsmen, sons of good farmers. In general terms the home farm of the English landowner is run (and always has been run) at a considerable loss. Not only can English landowners no longer afford this loss, but it seems probable that in the near future they will be called upon to farm larger areas of land than they do at present. It is the landowner's duty to see that his farm is a demonstration of economic management and an example of how much can be made from the land. Now I am convinced that the main reason for heavy loss on the home farm is that the type of foreman or bailiff usually employed is not the right type. Generally he is a superior labouring man who is paid his £150 or £200 a year. We want a much more highly educated man with an open mind and a capacity for organisation; and in the case of farms of over 500 acres he should be paid anything—£500 to £1000 a year—but the payment should be made on results. The maintenance wage should be quite small, and the rest of the salary should be in the form of a share in the net profits:—30 per cent. to 50 per cent., or 60 per cent. as the case may be. The advantages are:—For the young farm manager, the opportunity of working on his own on a considerable scale and of earning a good income (out of which to save capital), without being called upon to put down any working capital himself. For the landowner, the benefit of having a highly trained man—of an altogether higher calibre than he has heretofore been able to obtain—a farm manager working under conditions that call forth his utmost effort, as he has every incentive to make the farm pay. This form of partnership farming has been largely developed in the State of New Jersey—between busy town capitalists and Scottish farmers who have migrated. I have myself had a farm under this partnership arrangement, for the last twelve years, to my great profit and satisfaction. It would, I am sure, be well worth while and to the benefit of the two countries to make a determined effort to develop the partnership system between English landowners and the sons of really good Scots farmers. Great care should be taken in the selection, not only of the would-be "managing partner," but also in regard to the landowner to whom he is assigned; for it would be essential that the owner should agree to his farm being run as a commercial enterprise. The proper management of a 1000 acre or even a 500 acre farm is a large business, and the potential income-earning opportunity should be sufficient to attract really first-class men.

FARM PESTS.[1]

JAMES RITCHIE, M.A., D.SC., F.R.S.E.

Natural History Department, Royal Scottish Museum.

Mammal Pests—continued.

(2) DESTROYERS OF CROPS AND PASTURE.—With these we come upon a set of mammals belonging to very different categories from the predatory carnivores. They consist mainly of grass-eaters, and include examples of the orders of ruminants and rodents; but, in addition to the devourers of the crops meant for domestic animals or man, there are a few creatures which damage crops in other less direct ways, and amongst these another mammalian order, that of the insectivores, is represented.

It has already been pointed out that there is a close connection between vegetation and the amount of animal life in a country; and that the quantity of stock which a country bears tends to approach to the maximum which can be fed on its vegetation. It is clear, therefore, that any reduction in the amount of plant growth available for domestic stock, whether the reduction be due to the use of plants as food by wild animals, or to simple destruction of crops, must inevitably reduce the potential stock-carrying capacity of the land. Whether the reduction is serious or not depends very largely on the numbers of the wild creature concerned.

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[1] The first instalment of this article appeared in the July number of the *Journal.*

It is a curious fact that while in Britain man has been able to reduce almost to negligible proportions the animals which have preyed upon his domestic stock, he has met with little success in his efforts to reduce the numbers of wild crop-destroyers. Ruling out of court the case of deer, which have received special protection from another section of the community, the lack of success seems to be due largely to the habits of the creatures concerned, and not to any special slackness in the farmer's warfare; and chief of the qualities which have made for the success of the crop-destroyers are their adaptability as regards breeding-places and their unusual fecundity.

The crop-destroyers may be grouped into two classes, according to whether they use up the food supply directly or damage it indirectly. The former class will be dealt with first, roughly in the order of their agricultural importance.

The Rabbit.—The wild rabbit (*Oryctolagus* (*Lepus*) *cuniculus*) is a rodent, and an alien on Scottish soil. A native of south-western Europe, it was introduced into Scotland before the thirteenth century, and was at first strictly preserved on account of the value of its fur. In the centuries following its introduction it was deliberately transported to many new localities, and this, added to natural migrations to fresh areas on the part of the rabbits themselves, led to a more and more rapid spread, until it has now become a common and still increasing pest throughout the country. Two human factors have contributed largely to the success of the rabbits' colonisation of Scotland: First, the great improvements that have taken place in agriculture which have furnished the rabbit with abundant food supplies. The importance of this factor I have illustrated elsewhere,[1] by showing that during the first twenty years of the period called by Lord Ernle "the golden age" of British agriculture, the number of rabbit skins on sale yearly at Dumfries Fur Fair rose from some 10,000 in 1852 to 200,000 in 1871. The second human factor is the growing attention paid to game preservation, and the consequent destruction of the creatures which formerly kept down the numbers of rabbits (as well as of pheasants and grouse), the fox, the polecat, stoat and weasel, eagle and hawk.

But probably the most potent factor in the spread of the rabbit is its own fecundity, for a doe begins to bear at the age of some six to eight months, produces five to eight young in a litter, and four or five litters in a year. At such a rate of multiplication a single doe would, accidents apart, be represented some two years after birth by a progeny numbering about 300.

Rabbits, as a rule, avoid moist places, and prefer to live in sandy areas, well sheltered with heather, long grass or whins. In such places their burrows sometimes penetrate the soil in great numbers. The female constructs a separate burrow for her young, where, in a nest lined with fur from her own body, she deposits her blind, naked and helpless offspring.

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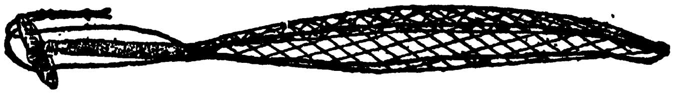
[1] See *Influence of Man on Animal Life in Scotland*, 1920, pp. 167 and 390.

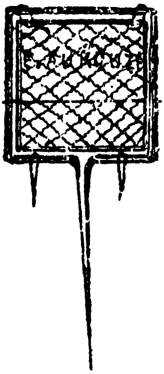
Economic Significance.—The activities of the rabbit are too well known to require detailed description. In wild areas it feeds upon rough grass, wild thyme, the shoots of heather, and especially upon the young growth of whin bushes, which may often be seen trimmed and close-cropped from the base upwards as far as the rabbits can reach by stretching on their hind legs. Recent investigations by Mr E. B. Farrow have shown that, where they are numerous, rabbits may exercise a marked influence upon the vegetation in the neighbourhood of their burrows or warrens, causing a gradual disappearance of heather, for example, and its replacement by an association of grasses. In the neighbourhood of agricultural land they cause very serious damage by eating and fouling grass, by devouring young green crops, corn and clover, and by invading the market garden. It ought also to be added that they give rise to indirect damage by inducing poachers to trespass. As a counter to their disturbances can only be set the facts that rabbits form a valuable food supply, and that their fur, for which alone they were formerly valued, still continues to be used extensively in the manufacture of felt and of fancy "furs." But their harmfulness to agriculture far exceeds their usefulness, and has given rise to successive efforts of legislation to keep their numbers within reasonable limits.

Destruction.—Rabbits, when enclosed in warrens, were, by the old statutes, considered as private property, and their destruction elsewhere declared to be a point of dittay or indictment. It was held, however, that rabbits were not game at common law or under the old statutes, and that in consequence a tenant was entitled to kill them for the protection of his crops, without the consent of the landlord. The passing of the Ground Game Act of 1880, "in the interests of good husbandry, and for the better security of capital and labour invested by occupiers of the land in the cultivation of the soil," made the position perfectly clear by giving to the occupier the right "as incident to and inseparable from his occupation of the land, of taking and killing ground game thereon." So troublesome have rabbits become to the farmer that it seems not unreasonable to suggest that if they are to be kept for commercial use, either on account of their food-value or of their fur, they should, in the neighbourhood of agricultural land, be confined in warrens, as was the intention at the time of their introduction to Scotland. Beyond the bounds of recognised and enclosed warrens, they ought to be reduced to the lowest numerical limits or exterminated.

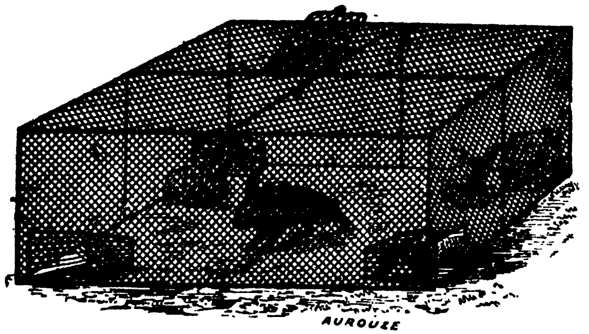
As indicated above, a tenant of an agricultural subject has a right under the Ground Game Act to kill rabbits on his farm under the limitations in that statute. It frequently happens, however, that considerable damage is done to crops by rabbits coming from the plantations on or adjoining the farm. As a general rule, the tenant has no right to enter these plantations, and in Scotland the law is not very clear as to whether he has a claim for damages against his proprietor or the owner of the plantations in respect of the damage done by the rabbits. There have been several Sheriff Court cases on this point, and decisions have been given both in favour of the tenant's claim and against it. The question whether a tenant in these circumstances would have a valid claim would depend entirely on the special circumstances of any individual case.



Bag-Net.—The net is placed over one opening of a burrow, while a ferret is set free in another, so that the rabbit is netted on bolting. The neck of the net pulls tight with a cord, and the handle affords an easy and secure grip. By M. AUROUZE, Paris.



Rabbit Excluder.—A device for preventing rabbits from re-entering their burrows, for example during a shoot. The point is driven securely into the ground in such a way that the rectangular frame lies against the opening of the burrow. The net or door lies within, and is hinged to the outer frame which carries the point. On issuing, the rabbit pushes up the net and escapes, but the net falling back into place, now effectively prevents the re-entrance of any rabbit which has emerged. Various types of rabbit excluders have been devised, the above being by M. AUROUZE, Paris.



Ever-Set Rabbit Trap.—A simple trap built of wire on the principal of some rat and sparrow traps. It is placed in a place where rabbits abound, and is baited with carrots, lettuce or some such delicacy, which are placed within. Access is easy to the rabbit through any of the numerous entrances, but its egress again is prevented by the structures of the inner ends of the entrances. By M. AUROUZE, Paris.

The methods of destruction generally employed are shooting, ferreting with dogs or nets, snaring at burrows or in runs, trapping, and netting either at the burrows or with long nets in the open field. In France they are occasionally asphyxiated by means of sulphur cartridges placed in the burrows.

The Brown or Common Hare.—The brown hare (*Lepus europaeus*) one of our native rodents, is almost universally distributed in the cultivated districts of Scotland. It is, however, most common in the Lowlands, and in the Highlands is found only in more restricted areas, in the upland valleys, and on the slopes of hills to a moderate height, its place on the higher ground being taken by the mountain hare. The brown hare is readily distinguished from the rabbit by its larger size and less rounded body, by its ears, which are longer than its head and possess a large black tip, and by the relatively much greater length of its hind legs. Up to the eighteenth century it was probably a rare animal in this country, but, like the rabbit, it has shared in the prosperity brought about by a generous cultivation which increased its food supply. During the day hares prefer to skulk in their "forms," rude resting-places above ground, generally situated among long grass, bracken or bushes; but towards evening they wander in search of food. Their speed when disturbed or pursued is proverbial.

BROWN OR COMMON HARE.
(From Bell's *British Quadrupeds.*)[1]

A hare breeds when a year old, and bears a litter of from three to five young several times a season, young hares having been found from January to November. Unlike young rabbits, the young, or leverets, are born with a covering of hair, with open eyes, and able to run; after less than a month they leave their mother and fend for themselves.

Economic Significance.—The hare is wholly vegetarian, feeding, mainly during the hours of twilight and darkness, upon various kinds of wild herbage, and too often upon the farmer's crops. Not only does it cause serious damage to pasture, and particularly to young corn, but during autumn and winter it feeds heartily in the turnip fields, destroying almost more than it eats, by giving rain and frost access to the nibbled roots. In its favour it can only be said that it itself forms a useful food supply, and that its fur is made use of in the manufacture of felt and "furs"; but these benefits are far from balancing its destructiveness.

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[1] This illustration is due to the courtesy of Messrs Gurney & Jackson, Publishers, London.

Destruction.—At common law the hare is regarded as ground-game, and as such was at one time strictly protected from all but the owner. The gradual increase in the numbers of hares made neccessary successive laws which aimed at a restriction of the growing pest. Indeed, in few cases can the varied history of a wild creature be traced more closely than in the laws affecting hares. In 1848 the hare was increasing, and so, in an Act passed in that year, destroyers of hares were relieved from the necessity of taking out a game certificate. Numbers continued to grow, and the damage to crops increased with the numbers, so that in 1880 the Ground Game Act was passed, by which, as already mentioned, the occupier of land gained equal right with the owner to take or kill ground game, The result was more thorough than legislators had foreseen, for the numbers of hares became so reduced that in 1892 the Hares' Preservation Act was passed, granting the hare a measure of protection by instituting, from March till July, a period when sale or exposure for sale is prohibited. Finally, during the War period, complaints regarding the damage done by hares became so insistent that the Board of Agriculture for Scotland found it necessary to issue an Order (April 1917) permitting the killing and taking, the sale and purchase or the possession of hares at any time when the killing or taking, the sale or purchase, or the possession thereof would otherwise be unlawful."[1] The law relating to the tenant's right to destroy hares, and as to claims for compensation for damage by them is similar to that explained above with reference to rabbits.

The irregular movements of hares greatly hamper trapping and snaring in the ordinary way, so that they are usually hunted with dogs, or shot; and their habit, when disturbed, of making for a gap or gate in a stone or other fence is brought into service by netting the gates and subsequently beating the field.

The Blue or Mountain Hare.—In contradistinction to the common hare, the blue, white or mountain hare (*Lepus timidus*)—which is smaller than its relative, and is otherwise distinguished by its smaller and rounder head, shorter ears and greyer colour—frequents the higher and usually waste lands, and is absent from lowland agricultural areas. It is a native of the high mountainous tracts of Scotland, north of the line of the Forth and Clyde, and may be regarded as a relic of the closing stages of the Ice Age; in its autumnal colour-change from dusky grey to white, it still betrays its former association with arctic conditions. The mountain hare has been introduced by man to many of the islands, and during the nineteenth century was planted in various places on the uplands of southern Scotland, where formerly it was quite unknown. Here it has found conditions so favourable that it has multiplied and spread from these new centres of dispersal, so that there is scarcely a moderately high hill in the southern areas which does not carry its colony. The mountain hare prefers shelter amongst heather or bracken, in peat bogs or even amongst stones, to a regular "form," and in such places the female produces probably two litters in a season.

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[1] This Order is no longer in force.

Economic Significance.—The feeding habits of the mountain hare are essentially similar to those of the common hare, but owing to the fact that it is mainly confined to waste moorland, where, in bad weather, it is compelled to feed even on lichens and fir-cones, the damage done by it to crops is insignificiant compared with that of its congener. Even when, on the approach of winter, it forsakes the high levels for more sheltered places in the valleys, it seldom descends to the areas of arable cultivation. Complaints, however, have been received of damage caused in high crofting districts, as well as in sheep runs where the hares have become too numerous. In such areas too serious multiplication ought to be balanced by reasonable reduction; but, on the whole, the mountain hare must be regarded as a local rather than a general pest.

The hares are destroyed by shooting, usually with dogs ; and since they lack the speed of foot and wariness of the common hare, they fall comparatively easy victims to the gun.

Red Deer.—Nowadays Scottish Red Deer (*Cervus elaphus scoticus*) are almost confined to the unproductive moors and wastes of the Highlands and larger Islands, north of the line of the Forth and Clyde. But in prehistoric days they were distributed throughout the length and breadth of the land, as their remains show, from the Pentland Firth to the Solway and from the East Neuk of Fife to the western coast. In the days before neolithic man introduced his domesticated animals they were the predominant grazing animals in the country. Even in the middle ages they were still common in the inland areas ; but agricultural progress was a main factor in banishing them from the most fertile lands, and there is clear evidence that the extension of sheep-farming was responsible for their disappearance from the Scottish Lowlands. This gradual compulsion exercised by agriculture has had an important result, for the present day isolation of the Red Deer in the waste places, has removed them from the category of general pests, and has brought it about that, throughout the greater part of their range, they no longer threaten the prosperity of the farmer.

Were it true that deer did not increase beyond the natural capacity of their territory to support them, little harm need be feared from them. But it is not so for, largely owing to the demands of the sportsman, most of the deer forests are stocked beyond their natural capacity, and this congestion, specially noticeable during the war, when the increase in numbers was little restricted by shooting, gives rise to severe competition for food.

Economic Significance.—In natural conditions deer feed mainly upon grass and heather, as well as upon the leaves and young shoots of trees and bushes, but this supply is often so insufficient that in several deer forests hand-feeding is resorted to in winter. Where the natural supply falls short of the requirements, deer may invade sheep-runs, with the inevitable result that the sheep-carrying capacity of the run is reduced. But damage may be done even to arable land, for in dry seasons, when food is scarce, long journeys may be made to corn-fields and, in the hard days of winter, herds of deer, especially hinds and fawns, seek shelter in the low grounds, with the result that turnip crops frequently suffer. In each of the counties of Perth, Argyll, Aberdeen, Inverness, Ross and Cromarty, Sutherland and Caithness damage to crops by deer has been reported to the Board of Agriculture for Scotland in recent years, and the Board found it advisable, in February 1917, to issue a special order authorising the occupier of any agricultural holding in Scotland, to kill, by any means available, and without a game licence, deer that were trespassing on his grazings or causing injury to his crops. While this order is no longer in force, it indicates the degree to which deer in certain areas had come to be regarded as pests of agriculture.

Should the recommendation of the Departmental Committee (1922) be carried out, that deer forests capable of carrying a full permanent stock of sheep, should, during a period of five years, be gradually converted into sheep farms, a corresponding gain to agriculture would follow, as well as a reduction of deer in those areas in which, since they most often lie near agricultural holdings, deer are most likely to be troublesome. At present a farmer who can prove damage done may claim compensation from his landlord in accordance with the provisions of Section 9 of the Agricultural Holdings (Scotland) Act, 1908. In that section it is also provided that where the right to kill and take the game is vested in some person other than the landlord, the landlord is entitled to be indemnified by that person.

Roe Deer.—The roe (*Capreolus capreolus*), smallest of our deer, is more widely distributed in Scotland than the red deer. Although, a century and a half ago, it had been driven, mainly by the destruction of woodland, to the counties north of the Forth and Clyde, it has, through protection and the growth of plantations which afford cover and sustenance, been induced once more to make its home in almost every county from the Pentland Firth to the Solway.

Economic Significance—In habit the roe differs markedly from the red deer, for the latter is rendered in great part harmless through its restriction to the moors, but the former prefers to dwell in woods with good cover, bordering arable land or pasture. To these rich feeding grounds small parties of roe are accustomed to stray in the dusk of the evening. This habit and the presence of roe deer in counties where high cultivation prevails, make the species a more general enemy of the farmer than red deer, and complaints of damage have been received by the Board of Agriculture for Scotland from counties ranging from Aberdeenshire to Dumfriesshire. When it neglects the farmers' crops, its food consists of grass, herbage and even fungi, and its tendency to nibble the young shoots of bushes and trees makes it a serious enemy of plantations.

Fallow Deer.—Unlike the red deer and the roe, the fallow deer of Britain (*Dama dama*) is no true native of the country, but an alien whose original home is the countries bordering the Mediterranean Sea. They are easily distinguished from red deer by their smaller size, their broad palmate antlers, longer tail, and white-spotted body. As a rule, fallow deer have been placed in parks and enclosures, and had they remained within these bounds they would have had no place in this account of farm pests. Centuries have passed, however, since fallow deer escaped from the paddock to the woods, and in the intervening time they have made themselves so much at home in Scottish woodlands that now they almost take rank with the native species. To-day, as I have elsewhere summarised, "they are to be found in a wild state from Drumlanrig in Dumfriesshire, in the south, through the wilds of Central Perthshire, the woods of the Tay Valley from Stanley to Blair Atholl, in the islands of Mull and Islay, to their northern outposts in the Dornoch woods of Sutherland," and in the woods about Rosehall in the same county.

Economic Significance.—Fallow deer frequent well-wooded districts, and live, like roe, upon grass and herbage, as well as upon acorns and chestnuts, where these are obtainable. Like roe also, they develop, where opportunity offers, an undue fondness for the crops of the farmer. In the beginning of the nineteenth century their destructiveness led to persistent attempts to exterminate a herd of wild fallow deer, descended from park deer introduced at Raehills in Dumfriesshire about 1780. With increase in numbers their depredations became so serious that expert marksmen were employed to reduce the herd, so that in a single week fifty were killed; but even this destruction did not put a stop to their increase nor to the damage done. It is true that at the present time complaints specifically relating to fallow deer are few, so far as Scotland is concerned, but the above instance is given to show that, where undue increase in numbers take place, the foreigner also may become an occasional or local agricultural pest.

SCRAPIE IN SHEEP.

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Historical.—The earliest definite record of the occurrence of scrapie in Britain, that one can find, was in 1732. In 1755, however, the disease had assumed such proportions, in certain districts, that there was a memorial to the House of Commons regarding its destructiveness from the breeders and feeders in the county of Lincoln. It affected at that time all the breeds in the South of

England. At the end of the eighteenth century it was extremely prevalent, and it should be noted, in reference to the method of spread of the disease, that at this time there was great activity in improving the various breeds of sheep.

The symptoms described as occurring in the disease at that time, were very much those observed to-day; while the views regarding its occurrence were practically identical. In particular, it should be noted that the disease was believed to be hereditary, that in-breeding tended to produce it, that it was not contagious and that it principally affected two-year-olds. Some thought that the ram tended to spread it, a view fairly common at the present time. At this time it was known under various names such as "Goggles," "Rubbers," "Rubs," "Rickets," "Shakings," etc.

The disease has been known in the Border districts of England and Scotland for the last sixty years at least. Its ravages there became much in evidence ten to twenty years ago. It is known there as "Scrapie," "Euky Pine," "Cuddy Trot," etc.

With regard to its occurrence in other countries, it has been known in Germany for over a hundred years and the symptoms and ideas about its causation are similar to those just described. The outbreaks occurred chiefly among highly pedigreed Merinos (Electorals), at a time when improvement of the breed was much in vogue. The disease has also been known in France, where it is known under the name of "la Tremblante," for a similar period: the information regarding it there is much the same.

Occurrence of the Disease.—*Breeds Affected.*—In England in the eighteenth century it appeared to affect all breeds. At the present day in the Border district it affects principally the Cheviots, the Leicesters and the Half-Breds. Cases are known in pure Suffolks bred in Scotland and in Suffolk. They are, however, rare among the Blackfaces, although they undoubtedly do occur. This, in all probability, is due to the different type of breeding that pertains in this breed, as will be discussed later. Cases may occur in other breeds, but this list includes all one knows of personally.

Age of Sheep Affected.—The great majority of the cases occur when the sheep are two years old. Cases, however, occur earlier than two years as also above two years, at the various age periods up to at least eight years old. The statistics with regard to the age incidence (eighty-one cases observed), are as follows:—One year, 0; two years, 56·8 per cent.; three years, 21·1 per cent.; four years, 18·5 per cent.; five years, 3·6 per cent. One ewe was one year nine months and three ewes were one year eleven months when they took the disease; all the others were two years and over. In the old records of the disease, it was noted that forcing young wethers for the early market tended to bring on the disease earlier.

Sex Affected.—It affects both sexes, in all probability equally. As rams are relatively fewer in number, a case among the rams, to the uncritical eye, bulks more largely. Cases occur in wethers, as has just been alluded to, but, at the present day, few wethers are kept till they are old enough to develop the disease.

Relation to Pregnancy.—There seems to be some relation to pregnancy because it is very frequently observed when a gimmer is having her first lamb. This, of course, may be due simply to the age of the animal, but the extra strain of pregnancy and lactation might presumably precipitate the disease. The statistics relative to this point, are as follows in regard to the eighty-one cases referred to above:—In ewes before lambing, 40·7 per cent., after lambing, 59·3 per cent. With regard to months of the year, the occurrence amongst these eighty-one cases was as follows:—January, 2·4 per cent.; February, 12·3 per cent.; March, 18·7 per cent.; April, 3·7 per cent.; May, 8·6 per cent.; June, 14·8 per cent.; July, 14·8 per cent.; August, 11·1 per cent.; September, 6·1 per cent.; October, 0 per cent.; November, 2·4 per cent.; December, 5·1 per cent. Lambing began in the beginning of March. The large proportion of the cases towards the end of gestation and lactation should be noted.

Season of the Year.—This has just been referred to and it will be seen that most cases occur during the six months from February to July. It is unlikely that the season of the year, of itself, affects the occurrence of the disease, except that the itching will be more trying during the hot weather and that winter weather will predispose to intercurrent affections which may kill off the animals.

Duration of the Disease.—It is difficult to make a definite statement regarding this. Some die in a few weeks before any signs of emaciation have set in; others again last a long time wasting away to a shadow. Intercurrent disease often cuts them off in their weakened state.

Recoveries.—Very few cases recover from the disease once it is established. Three cases, however, of recovery definitely occurred in our experience, where two different and experienced shepherds noted cases where sheep, as gimmers, showed all the symptoms of the disease, especially the rubbing on the head, gradually lost these symptoms and were eventually drafted away as old ewes.

Symptoms of the Disease.—The disease may be divided, according to the predominance of the symptoms, into two varieties (1) the rubbing or itchy and (2) the trotting variety. There are also mixtures of these two. These same varieties have been noted in Germany, as indeed is expressed in the terms, the "gnawing" disease and the "trotting" disease. The itchiness may occur in the sheep when it is fat or when it is lean and emaciated. The alteration of the gait occurs only in the lean emaciated sheep, a point of importance in regard to an understanding ot the cause of the disease, inasmuch as the gait is altered only when the muscles are much disintegrated.

The symptoms will be described generally, without reference to the varieties of the disease as just mentioned. The sheep are often in very good condition when the first symptoms are observed, and this appearance of well-doing is often enhanced by their rubbing against clay banks, etc., a procedure which gives a bloom to the fleece. At the beginning, the animal shows a nervousness and restlessness, an irritable condition, with flicking of the ears, fixed gaze, twitching of the tail, as if troubled by flies when indeed these insects could not be present. When the attempt is made to catch such sheep, they often tremble violently and become convulsed. When they are caught, however, and rubbed they seem highly pleased, bending down the back and pressing against the hand. They remain standing, without being held, as long as the rubbing is continued. When rubbed, they make vigorous chewing movements with the jaws and sometimes bite the operator; at other times they become quite frenzied with the rubbing, tremble all over, with foam working out of the corners of the mouth. They rub against fences, earth banks, etc. Often they will be found in the vicinity of these and when driven away persistently return. They bite themselves and pull strands of wool out of their fleece. Gradually they rub off the wool from their body especially from the crown of the head, the flanks and the root of the tail. They often sit down on their haunches on the ground, like a dog, and bore their buttocks into the earth. Their skin is quite clean showing no signs of scab; it readily becomes flushed with the rubbing. Later in the disease, with the amount of rubbing, ulcers and scabs appear on the rubbed portions. As the disease progresses, the animal becomes more and more emaciated; the belly dwindles, the wool gets hard and assumes a bluish tint and the fleece hangs down in long tags. The animal now begins to show signs of weakness of the muscles. It walks all right, but, instead of galloping like a normal sheep, it trots—hence one of the names. At this stage it is difficult to drive from place to place. It trots for a short distance and then tumbles down in a heap; if made to get up, it trots a short distance again and then tumbles down and so on. The itchiness usually persists in this stage, but in some cases it disappears. The animal continues to eat greedily during the disease, the temperature is not raised and there is no diarrhœa. Its intelligence is unabated and there is no evidence of involvement of the brain. As already mentioned, it may die early in the disease, before the emaciation and trotting appear, or may die when these do appear, from weakness or some intercurrent disease.

Post-Mortem Examination.—In the sheep, which die early in the disease, nothing is usually seen. In later cases, one detects, by naked eye examination, excoriations of the skin and large pockets on the flanks, due to undermining of the skin, containing rounded white fatty bodies. These are caused by the rubbing. There is also extreme wasting and a gelatinous watery appearance of the muscles. On microscopic examination of the various tissues of the body, one detects nothing abnormal, except in the muscles. These are loaded with a protozoan parasite, the sarcocyst, which is a cigar shaped body, filled with small sickle shaped structures and surrounded by a capsule. This is situated inside the primary muscle fibre, the organ responsible for muscular

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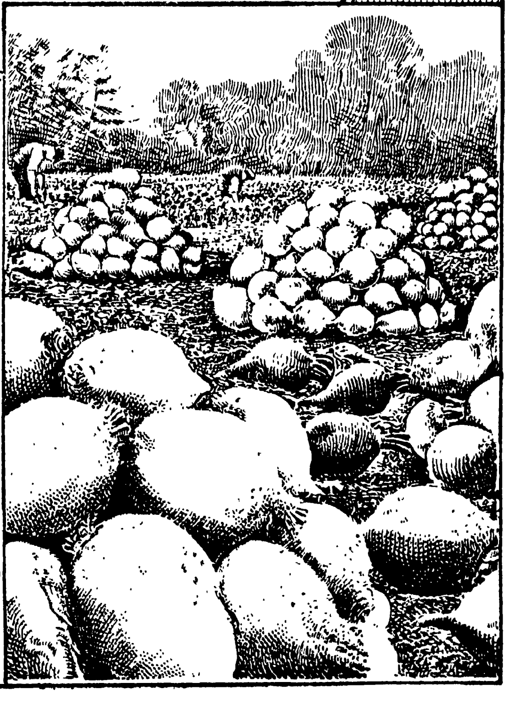

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action. Its situation here interferes with the proper contraction of the muscle and hence with the movements of the animal. All the more is this the case, when, as happens in certain instances, the muscle consists of little else than parasite and damaged contractile tissue.

Symptoms of the Disease Explained.—As just mentioned, the muscular weakness of the animal and its peculiar gait is to be explained by the situation of the sarcocyst inside the muscle fibre. The itchiness is to be explained by the fact that the sarcocyst contains a toxin, the sarcocystin. When this substance is injected into the bloodvessels of a rabbit, it produces within a few seconds the most violent itching and subsequent death of the animal.

Spread of the Disease.—The disease is not contagious in the ordinary sense. All observations, on the natural disease and experimentally, go to show this. It is, however, undoubtedly transmitted from the diseased mother to the offspring. While this is true in the very large majority of cases, a diseased mother may give rise to a healthy lamb. On the other hand, an apparently healthy mother may give birth to a lamb which eventually dies of scrapie. The disease is not transmissible from sick to healthy by the inoculation of the organs of the sick into the healthy. An experiment carried out during this investigation and which lasted for four years, showed that scrapie could be transmitted to healthy lambs by their being suckled on scrapie mothers. Other lambs, in intimate association with these ewes and lambs, but being suckled by healthy mothers, did not take the disease. The disease was, therefore, presumably passed to the lambs through the milk of the foster-mothers.

It is often alleged that the ram is a prolific means of spreading the disease, and it is necessary, therefore, to look into this question a little more closely. It would appear possible that the ram might transmit it to a healthy ewe in the act of copulation, might carry it from a diseased ewe to a healthy ewe, or might transmit it to the lamb with or without affecting the ewe. It can be said with confidence, however, that there is no case on record where it has been proved that the ram has spread the disease in any of these ways. The case on which the assumption is based is usually somewhat of the following nature. Scrapie appears in a previously healthy flock and, without any scrutiny of the evidence for such a view, the ram is blamed for bringing in the disease. This would seem a bald statement of the case, but it is strictly true. The ram indeed, in the case cited as an example, had not had the disease and never developed it; and there was no evidence even that the disease existed in the flock from which he came. On the other hand, the facts are that when scrapie appears in a flock (apart from buying in a diseased lot), it appears, at the beginning, as a single case or at most two Now as a ram serves on an average sixty ewes, if he were the producer of the disease, then, in analogy with other diseases one knows of so passed, the number of cases ought to be very much greater. Again, there is no guarantee whatever that the original ewes were entirely clear of the disease;

and indeed the probability is all against their being so, owing to the custom of buying in every year a certain number of ewe lambs or gimmers to make up the age numbers. These ewe lambs have to be bought in the open market or out of flocks where no record is obtainable as to whether the disease exists or not. They are bought in numbers varying from a score to five score or more, and a simple arithmetical computation will show that the chances of bringing in the disease by the ewes are incomparably greater than by means of the ram. Apart from this altogether, as has been already mentioned, the outbreak of the disease resembles more a ewe outbreak than a ram one. We will, however, consider the question further. One knows of many instances where a ram has been found suffering from scrapie on his being brought in from the ewes; yet the disease did not appear in any of his progeny, although they were kept to the requisite age for the disease to develop. Again, with the sale of scrapie rams from scrapie flocks to sheep owners all over the country, the disease ought long ago to have been rampant all over the country. Yet this is not so.

The question of possible relationship of the ram to the disease could be settled experimentally. I have tried on several occasions to set such an experiment going, but, for various reasons which need not be entered into here, have been unable to do so. I am hopeful, however, that in the near future I may be able to accomplish this. It should be remarked, however, in the interpretation of the results of such an experiment, that, should cases occur after the use of a scrapie ram (provided that all other sources of error were excluded), it is possible that the ram has transmitted a tendency or constitution of body, which made the offspring more susceptible to the disease, without the actual cause of the disease itself being transmitted. A similar condition of matters exists in connection with tuberculosis. The tuberculous constitution or diathesis is transmitted in this case without the tubercle bacillus—the actual cause of the disease—itself being transmitted.

Explanation of the Distribution of the Disease.—The reason why scrapie is so rampant in the flocks of the border districts and not elsewhere would appear to be because of the method of breeding in vogue in this district. Here, the practice is to keep up the ewe stock from the gimmers, the progeny of the older ages being a crossed breed and sold to the butcher. This does not mean that the disease is started by this procedure. It is, however, a very potent method of spreading it and of introducing it into a flock. It is a hereditary disease, and the gimmer age is the one most susceptible to it. To keep up the ewe stock, allowing for the ram lambs, every ewe lamb has to be kept. It is easy to see how, by a process of geometric progression commencing from a few cases, the flock in a few years may be saturated with the disease. Again, the buying in every year of a few ewe lambs, to make up the age numbers, a process necessitated by the method of breeding, provides a ready yearly method for the introduction of the disease. For the reasons given, the disease is rampant among many Cheviot flocks, where first-cross half-bred lambs are reared, as also among the half-bred flocks, where cross lambs are taken from the older ages of ewes. For similar reasons, but acting in an opposite direction, the disease is hardly known in Blackface stock. Let us now contrast this method of breeding with what occurs elsewhere in Scotland. There the methods used tend to prevent its spread. Single cases of the disease must occur in Blackface stocks according to the view propounded here as to its causation, and, in fact, actually do occur. The procedure there, however, is to select, for keeping up the breeding stock, the best ewe lambs from all the ages, with the result that a gimmer's lamb, being a poor lamb, is rarely chosen. If, however, one is chosen and it developes scrapie, its lamb, being badly nursed, stands no chance of being retained in the flock.

We will now consider "In-breeding" as a cause of spreading the disease. Since the disease was first described, in all the countries where it has occurred, this procedure has been regarded as a method not only of spreading but also of originating the disease. There is indeed no doubt that the disease, in many of its outbreaks, has arisen in intimate association with a process of improvement of the stock where in-breeding has played a large part. There is also no doubt that in-breeding tends to concentrate and aggravate any hereditary taint once acquired, not only from the point of view of handing on the actual cause of the disease, but also from the point of view of transmitting the susceptible constitution. And scrapie is notoriously a hereditary disease. It should be mentioned, however, that the view is not expressed here that in-breeding of itself necessarily originates the disease.

Detailed consideration of Sarcocyst as cause of the Disease.— It has already been intimated that the sarcocyst is, in all probability, the cause of the disease, and it has been shown how the idea of the sarcocyst explains the two prominent symptoms, namely, muscular weakness and the itching. The disease, too, has been seen to be hereditary. Another question, now, is as to whether there is any evidence that the sarcocyst is transmitted hereditarily. Theobald Smith has brought forward evidence that, in the mouse, in which sarcocysts cause a very fatal disease, the disease is transmitted, in at least one way, namely, by the mice eating one another. Apart from this one instance, no evidence has been brought forward of the sarcocyst being transmitted in any other way, and, obviously, this method could not hold for a graminivorous animal. Experiments were, however, performed in the present investigation, which showed that lambs from scrapie mothers could develop sarcocysts in their muscles, even although they had been taken from their mothers at the instant of birth and brought up on cow's milk, away from contact with sheep and in surroundings where sheep had never been before. Obviously, in this case the sarcocysts were passed from the mother to the lamb through the uterus. Of four lambs, treated in this way, one of them at the expiry of two years developed scrapie. Biting insects, such as

Keds or Ticks, as possible transmitters of the parasite, were excluded in these experiments. As has already been intimated, scrapie is transmitted, also almost without fail, to healthy lambs when they are suckled on scrapie foster-mothers. Presumably, therefore, the sarcocyst infection is transmitted in a more concentrated form through the milk than through the uterus. Since these observations were made, evidence has been accumulating that trypanosome infections (also due to a protozoan parasite) can be passed from mother to progeny in a similar way.

The sarcocyst is present in practically every sheep to a greater or less degree, and the question arises how it can be stated, as is done here, to be the cause of the disease scrapie. The view is that the symptoms of scrapie appear when the animal is over-run with the parasite or when the parasites are of enhanced virulence. In every case of disease there are two factors at work, the resistance of the animal body and the virulence of the infecting organism. This holds equally well with protozoan parasites as with bacteria, with regard to which latter the statement is axiomatic. Such a view regarding the disease predicates the existence of scrapie over a much wider area than is usually recognised, and especially among hill stocks in isolated areas. Individual cases, as already mentioned, undoubtedly do exist in such areas, only they are not recognised in most cases as such. In any case the method of breeding in vogue as already indicated, entirely precludes the spread of the disease in such places. The question now arises, what determines the excessive growth of the sarcocyst in one individual animal as compared with another, for undoubtedly certain sheep can be found teeming with the sarcocyst at the age of two years, whereas others can be obtained living to the age of six to eight years in which the sarcocyst can be found, but only with difficulty. This will be found to be the same question as to how scrapie starts originally in a flock where it has not been brought in from the outside and raises the question of the *de novo* origin of the disease. The possibility of such an occurrence is of great importance in a consideration of the relation of the ram to the disease, as has already been pointed out. The following facts may tend to throw light on this point. In the early records of the disease, it was observed that good feeding brought out the disease earlier, and that sheep fed on rich meadows were more liable to the disease than those pastured on poor soil. Specifically it was alleged that forcing young wethers for the early market tended to bring out the disease earlier. There is a hint in these allegations of the importance of nutritional factors in the origination of the disease. The following case, which is fully vouched for by a reliable witness, also has a bearing on this point. One hundred and sixty half-bred ewe hoggs were bought from a hill farm, reputed to be free from the disease. They were taken to a farm in the neighbourhood, thoroughly jumbled up, and then divided into two lots without selection. Sixty were kept on the last farm, which is a heavy clay, while a hundred of them were sent to another farm, the soil of which is of a light nature. Of the "sixty" lot not one developed scrapie, while a very large percentage of the "hundred" lot died from scrapie. The sheep on either farm had not been in contact with scrapie cases. So far as could be observed, the two lots had been subjected to exactly the same treatment. Here then is a case of apparent *de novo* origin of the disease on a fairly large scale, or alternatively, supposing that the disease did exist on the original farm from which the sheep came (for which assumption there is no warrant), the occurrence of the disease in such marked proportions in the one lot and its absence entirely in the other, considering the way the lots were obtained, requires explanation. One cannot, it is true, put a finger on the exact determinant, but one suspects that it is, to speak in general terms, something nutritional which has allowed a dormant potentiality to assert itself. Let us consider another case of a somewhat similar nature which, apart from any bearing it has here, requires to be recorded for its importance. It is the habit on certain low-ground farms to buy Cheviot ewe lambs, which must be seconds or thirds, from upland hill farms for the purpose of breeding first-cross half-bred lambs by crossing with Leicester rams. Now in a great many instances, without scrapie appearing in these lambs themselves or in the rams with which they were crossed, scrapie has nevertheless appeared in their progeny. As usual in such cases the ram has been blamed for the introduction, without, however, any evidence being forthcoming, as happens in all such cases, for the rams being diseased. There are in such cases other more likely possibilities however. In the first place, the animals in which the disease has occurred, are crosses with a much softer and more rapid-growing sheep—the Border Leicester—and this introduces, as already discussed, the question of constitutional resistance against some dormant potentiality, without raising, however, the question of actual transmission of the disease from the ram. Again, these sheep are now being pastured and fed on much richer land, with all that implies, as already discussed. But again, and most important, the original ewe lambs are in a sense the "rejects" from the hill stocks and will include a large proportion, if not all, of the gimmers' lambs. We have seen already that there is considerable evidence for the occurrence of scrapie in small amount in hill stocks, and such cases or those with the disease potentialities would find their way naturally into these "rejects."

In concluding this section, it may be mentioned that the sarcocyst theory of the disease affords a ready explanation also of the long incubation period, which lasts from two years up to eight years. This period would appear to be necessary for the parasites to multiply sufficiently to produce disease effects. It would appear, further, that there is no happening in connection with the disease to which this theory does not give an easy and unforced solution.

Methods of Dealing with the Disease.—We come now to a consideration of the final and, in many ways, the most important aspect of the subject, namely, that of the methods of dealing with the disease. Some drastic methods have often been used, such as selling out the whole stock in one batch and replacing it by new. This is a very expensive method, and there is no guarantee, things being as they are, that the disease will not be brought in again with the new stock. A method, based on the same principle but much less wholesale, is the gradual elimination of the ewes as draft ewes and restocking at the same time with fresh bought in young stock. This has often been done, and is quite successful, there being no danger of the old ewes infecting the young stock even although they mix indiscriminately with one another. There is, however, always the danger, as already mentioned, of importing the disease with the young stock. In an article on the subject published in 1914[1] it was recommended, for the preservation of an already healthy stock from the disease, that the ewe stock should be kept up from the progeny of the old-age ewes, and that those bred from the younger ages should be sent to the butcher, an inversion of the already existing order of things. This recommendation was made because scrapie, as already mentioned. was recognised to be a hereditary disease, and as producing the largest number of cases when the animals were two years old. In carrying out these measures, questions of telegony and difficult births for the gimmers, when Oxford Down rams are used for crossing purposes, do not merit consideration in connection with the prevention of such a disease as scrapie. The recommendation was made, as already said, for the prevention of scrapie arising in a healthy flock. I have no notes of its use for such a purpose, but I have obtained, thanks to generous contributors, records of its use for the elimination of the disease from an already infected flock. The results of one of these records, which has been kept with all the accuracy and detail of a laboratory experiment, will be more especially referred to. The part of it bearing on this point may be put briefly as follows in tabular form :—

Year.	No. of Ewes.	No. of Scrapie Cases.	Remarks.
Oct. 1911-12	131	0	
,, 1912-13	149	5	
,, 1913-14	159	4	
,, 1914-15	152	14	
,, 1915-16	154	29	In 1915–16 Suffolk rams were put to younger ewes and produce sold. Ewe stock bred from old ages.
,, 1916-17	154	24	
,, 1917-18	115	5	
,, 1918-19	91	6	
,, 1919-20	105	2	
,, 1920-21	95	1	
,, 1921-22	92	0	

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[1] M'GOWAN. *Investigation into Scrapie. Bulletin, Edinburgh and East of Scotland College of Agriculture.* Wm. Blackwood & Sons, Edinburgh, 1914.

According to the *rationale* of the process, the results of the method should become evident two years after it was instituted. Here it was begun in October 1915, and the marked fall in 1917, in what otherwise in all probability would have been a progressive increase should be noted. The progressive fall thereafter to zero should also be noted. The existing conditions of matters may be looked at in another way. If we separate out from the original record the scrapie cases according to the year in which they were born, it will be found that no scrapie cases were born from the year 1917 onwards.

It has already been stated that the method was not recommended in the beginning for the eradication of the disease from a flock already affected. This was in deference to the well-known fact, as has been already disclosed, that the disease occurs, although in diminishing numbers, in sheep even as old as eight years. The results here obtained are, therefore, all the more striking, although it was expected even on the first promulgation of the idea for preventive purposes, that it would considerably reduce the numbers in a diseased flock. Another point, however, arises. One has noticed that the disease is more virulent, causing death earlier of course and of a much larger number of sheep when it attacks them at two years old. As the number of the cases grows less, the disease becomes of a milder and more chronic type, and it tends to affect, more and more, older ages of sheep. Statistical evidence of this may be had from the record already referred to. Prior to 1917 there were sixty-seven cases, with age incidence as follows:—One year, 0 per cent.; two years, 61 per cent.; three years, 16·4 per cent.; four years, 17·9 per cent.; five years, 4·5 per cent.; subsequent to 1917 there were fourteen cases, with age incidence as follows:—One year, 0 per cent.; two years, 35·7 per cent.; three years, 42·8 per cent.; four years, 21·5 per cent. The alteration of the age incidence, as disclosed by these figures, should be noted. This occurrence will, undoubtedly, in many cases have the effect of rendering very difficult the stamping out of the *last* case from an infected flock by the above measures.

With regard to a possible cure for the disease, although a few cases of natural recovery have occurred, not much hope can be held out, owing to its very nature, of benefit from the use of medicines, vaccines or sera. These would be expensive to prepare, if they could be prepared at all, and would require to be administered over a long period, two considerations which would prevent their use on commercial stocks.

[It is a very pleasant duty to acknowledge information and assistance generously given by many helpers. In connection with such a subject most informants would doubtless prefer to be anonymous, but, as I have his permission, I should like to acknowledge the help derived from the information accorded me by A. M. Douglas, Esq., Butchercote, St Boswells. The statistical treatment of the subject is based on material supplied by him.]

THE BIOLOGIST ON THE FARM.—No. VIII.

PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

Biology of Autumn.—The climax of vital activity is in summer; there is a gradual waning in autumn. The tide turns and begins to ebb. There is withering and drying up, with which we may associate the ripening of fruits and the scattering of seeds. There is the characteristic fall of the leaf. Many animals set about storing for the winter, either inside or outside of themselves. Many begin to be inert, *e.g.*, as cocoons; and others begin to die. The majority of our birds leave us "for warmer lands and coasts that keep the sun." There are often showers of gossamer, which indicate that small spiders are being borne hither and thither, like the thistle-down, on the wings of the wind. Of course there is still a great deal of activity, for the very fact of seed-scattering implies a vigorous harvesting on the part of ants and the like that lay up stores; and the very fact of leaves falling affords opportunity for great burying industry on the part of earthworms. On the whole, however, the intensity of life is waning, and we see the humble-bees dying off till only the queens are left. The same is true of the empty wasps' nest, which is almost an emblem of the autumn. Looking at the autumnal phenomena in the broadest possible way, we may distinguish two aspects. There is the swing of the pendulum from great activity towards rest, and there is manifold preparation for the hard times that are coming. In other words, there are vital rhythms and there are adaptations to external periodicities.

The Disappearance of the Humble-Bees.—The agricultural importance of the humble-bees is great, for they play a big part in the cross-pollination of clovers and other useful plants. Throughout the summer they have been very busy, the climax being in July. Until that month the queen has produced only "workers," but in July she produces drones and queens, and their appearance is the beginning of the end. When they are mature the young queens leave the nest and the drones rove about in search of them. As the weather gets colder, the fertilised young queens seek out comfortable corners in the mossy bank, and it is generally believed that they alone survive to the following year. It is possible, however, that some old queens—their mothers—also live on. In any case, all the workers and drones die off. It may be noted that the male or drone of the humble-bee genus (there are many different kinds) is much less helpless than the hive-bee drone and is able to forage for himself among the flowers. The humble-bee queen has, like the workers, an arrangement of pollen-collecting hairs and a curved almost unbarbed sting which does not remain in the wound. The hive-bee queen has no pollen-basket and her sting is unbarbed, whereas the worker has a pollen-basket and a barbed sting which cannot usually be withdrawn from a wound. In other words, the differentiation between the functional females or queens and the sterile females or workers has gone much further in the hive-bees than among humble-bees. As a sting is a transformed egg-laying organ or ovipositor, we cannot expect one in drones.

Depredations of Red Deer.—Originally a forest animal, the red deer is typically a leaf-eater. It is fond of the leaves of beech, alder, hazel, and so on, not excluding ivy. When trees are not available, it falls back on grass and heather tops. It has a great liking for acorns. If that were all no one would say it "Nay": but the red deer is a rover, to whom distance means nothing and walls mean little, and it is an epicure with a good memory. So, as everyone knows, it visits gardens and orchards at dusk and dawn and goes for cabbages and apples. It is fond of carrots and potatoes, young corn and ripe corn. The hinds eat down the turnips as sheep do; but the stag, as Richard Jefferies well describes in his *Red Deer*, goes through the turnip field, wrenching up turnip after turnip, and jerking it backwards so that part remains in his mouth while the rest is thrown over his shoulder. In this disdainful way he destroys much more than he devours. As the red deer is a very admirable relic of the large mammalian fauna which used to be at home in Britain, and as it remains able to thrive on areas at present almost useless agriculturally, we cannot but wish it well, looking at the matter from a detached point of view. The only thing to do is to try to secure that those who enjoy "hunting the deer" should erect fences strong enough and high enough to keep the aristocratic ruminant within bounds. This is well done in many places and the farmer sleeps in peace.

In-breeding Again.—The biologist on the farm has had repeated occasion to refer to the conclusion that close in-breeding among healthy stock with no undesirable recessive characters is not in itself the cause of deterioration. In the *Anatomical Record* (xxiii., 1922, p. 97) Mr H. S. Colton gives an interesting case of a self-fertilised line of a freshwater snail (*Limnæa columella*) which was continued for forty-seven generations. In 1911 a snail, isolated in a vivarium, laid a mass of eggs; the resulting young snails were isolated and cross-breeding was prevented. The line has continued, but there has been no hint of any deterioration. It is a far cry from water-snails to cattle; but this case of long continued in-breeding (as self-fertilisation is) is very cogent.

Shells of Pigeons' Eggs.—What seems at first sight a simple case of variability or modifiability which readily crosses the line of safety is to be found in the shells of pigeons' eggs. Professor Oscar Riddle has shown that an individual pigeon may produce soft-shelled, thin-shelled, normal-shelled, or extra-thick-shelled eggs. The shell-making is variable, and if the shell is very inadequate the embryo is apt to die. As a matter of fact, however, the inadequacy of a particular shell is but loosely correlated with the death of the particular embryo contained within it. An unknown and more deeply seated cause, affecting ovum as well as oviduct, is responsible for both the occasional inadequate shells and the numerous early deaths of embryos. Darwin pointed out long ago that there were pigeons with bills so short and weak that the young birds could not make their way through the egg-shell without man's assistance. Such a variant occurring in natural conditions would immediately suffer elimination. Similarly, a variation resulting in too thick a shell or too thin a shell would be immediately fatal. When we think of these things we understand better what Darwin meant by the ceaseless scrutiny to which variations are subjected by natural selection. Almost every novelty is sifted, not once but many times.

A Philosopher with Nature.—This is the title of an interesting volume of essays, mostly previously published, by the late Mr Benjamin Kidd whose *Social Evolution* excited so much interest about a quarter of a century ago. He was a keen and sympathetic observer, especially as regards the habits of animals, and his reflective habit of mind, always inquiring into the *significance* of this or that country sight, is what everyone wishes to cultivate. He is listening, for instance, as we all have listened, to the calls of birds, like lapwing and curlew; and the question rises whether this primitive language, which was, to begin with, a language of the emotions, is a kind of *lingua franca* intelligible in some measure to a great variety of species. " From the outskirts of the crowd of mallard comes the quick plaintive call of the warning curlew; and every bird, thrilled by some primordial instinct of alarm, is instantly in the air with a roaring sound of wings." Of course this is a very simple case.

The young mallard comes and nestles on the observer's bare feet, tilting its beak to look inquiringly upwards, but showing no trace of instinctive fear. Yet the mallard has probably been the most universally hunted creature on earth, and the mother-bird is standing on a tussock near by, " chattering with emotion, every feather quivering with excitement. The hold of the Great Terror of Man is upon her. In a few days, nay, in a few hours, she will have taught it to them, and they will have passed irrevocably into another world." But, to begin with, the young birds are without prejudice as regards man. This is the ever recurring problem of hereditary "nature" and extrinsic "nurture": character is a product of the two.

Chickens, Pigs and Hookworm.—There are many threadworms or nematodes which spend part or the whole of their life in the soil. Some, like the eelworm of wheat, become parasitic in plants; others, like the hookworms, pass from the soil into animals or man. As everyone knows, the hookworms of warm countries are very serious human parasites, sapping man's vitality and producing " tropical depression." As the larvæ pass from the soil through man's skin, it is of the utmost importance to keep the soil from being widely infected. But this is very difficult around villages and among plantations ; it is practically impossible as long as the natives cannot be induced to conform to simple sanitary precautions. In the meantime the interesting question arises as to the dissemination of hookworms apart from man, and in this connection the rôle of chickens and pigs has been studied by Ackert and others. While the eggs and young larvæ of the hookworm *may* pass through the chicken's food canal without being injured, this is not always the case ; and it is concluded that chickens do more good than harm in this connection. But as to the free-ranging pig, the conclusion is that it plays an important part in dissemination of hookworm eggs with which man has polluted the soil. Moreover, the pig has a species of hookworm all its own.

Instinct and Intelligence.—When bees build their comb, or a spider spins its web, or a sand-wasp provisions her burrow with paralysed victims, we have to do with *instinctive* behaviour. It is the outcome of an inborn capacity for doing apparently clever things ; it does not require to be learned ; it tends to be a routine performance, and in spite of the extraordinary perfection of its actions, a predominantly instinctive creature like a wasp is apt to be sadly non-plussed by some slight disturbance in the conditions. It is likely enough that there are different kinds of instinctive behaviour, and it is probable that instinctive promptings are often assisted by intelligent experiment. As a rough-and-ready test among creatures of "the little-brain type," such as ants, bees and wasps, one may say that instinctive behaviour is marked by its routine character, by being performed with a considerable degree of perfection the very first time, by being shared equally by all members of the species of the same sex, and by remarkable limitations when something goes a little awry. What we must avoid is talking nonsense about animals having instinct and man reason ; or the lower animals having instinct and higher animals intelligence. As an example of intelligence among insects we may take the case of one of the hunting wasps, a species of Pompilus, which hunts trap-door spiders. It opens the lid of the shaft of a certain spider, and descends ; it stings its victim and drags it up—to serve in a paralysed condition as part of the larder for the young wasps when they are hatched. So far there is nothing very remarkable as wasps go ; but let us follow the story. When the autumn comes the trap-door spider makes a second shaft to its burrow, diverging at an angle, and opening on the surface not far from the first entrance. Both entrances have doors. It is no longer so easy for Pompilus to catch its spider, for the burrower may escape by the second door while the wasp is entering by the first. What is Pompilus to do? It has three devices, and the very possibility of alternatives leads us to look out for intelligence. Its first device is to break off the doors, which brings the spider up to try to repair the damage. The spider is then caught. Its second device is to insert its tail in the first entrance and then withdraw it, keeping an eye meanwhile on the second door by which the spider is likely to try to escape. Its third device is to rap first at the one door and then at the other until the spider gets excited and makes a rush. But the wasp is almost always too quick for the spider. The ingenuity and variability of the behaviour must be regarded as pointing to intelligence. There is a plastic appreciation of the situation.

Intelligence of Sheep-Dogs.—No animal is more relevant to the farm than the dog, and none shows more intelligent behaviour, as contrasted with what is instinctive. The shrewdness of a good collie is worthy of the most enthusiastic admiration, and that need not be lessened when we understand it better. The domestic dog has probably been evolved several times from different ancestors among carnivores that hunt in packs. It is generally agreed that some dogs are domesticated derivatives of wolves and jackals, and that some of the characteristics of dogs may be traced back to the discipline of a social mode of life. Mr Benjamin Kidd referred to the dog's devotion and exclusive attachment to his master and his master's household, his "extraordinary loyalty, the remarkable sense of obedience which will hold him to a command for days and weeks, the power of control which he exercises over his strongest emotions, and the innate moral sense which may be observed to render a well-trained dog miserable if he fails in what is expected of him." These high qualities are the flowers of a constitution which was rooted in the pack, when the ancestors of the dog hunted in intelligent co-operation with their companions. "The dog has probably still some sort of conception of his place as member of a co-operative group and of his master as the wise and resourceful leader of it." The sheep belong to his pack; he assists the wise head of the pack in shepherding them. That he should occasionally worry them is a readily intelligible lapse.

MILK-YIELDS, COSTS PER GALLON AND FINANCIAL RESULTS.

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THE relation between the average annual milk-yield per cow and the final cost per gallon, and between the cost per gallon and the net financial result of milk production are matters of great importance in the economy of the dairy farm. On the one hand, the need for, and possibility of, a considerable improvement in the average milk-yield of our dairy herds is being emphasised by Milk Recording Societies all over the dairying sections of Great Britain (as well as elsewhere); on the other, less attention is being paid to the ultimate effect of such an improvement upon the production-cost per gallon and upon the financial result (profit or loss); in fact, it is too readily assumed that increased milk yields per cow must invariably lead to corresponding increases in the net financial returns. On the one hand, it is urged that the consumption of milk is too low for the general welfare of the nation; on the other, it is asserted that milk-producers have difficulty in finding a profitable market for the existing supply. In this paper, however, it is not proposed to discuss the larger issues which would be raised by a gradual increase in the total milk supplies due partly to a gradual increase in the average milk yield per cow.

It is clear that the inter-relationships amongst milk-yields, costs per gallon and financial results may be considered from two points of view, according to whether the herd or the individual cow be taken as the unit, *i.e.*, according to whether conclusions are to be based upon the average results from each of a number of different herds under different management or upon the results from individual cows within the same herd under the same management. In this article, attention will be concentrated chiefly upon the first mentioned point of view, for the principal reason that, so far as this country is concerned, no complete and reliable data for individual cows have yet been published.

Taking the dairy herd as the unit of comparison, we have to answer such questions as: what is the relation between the average yield of milk per cow per day and the final cost per gallon, *i.e.*, does a high average yield per cow necessarily or even generally lead to a low average cost per gallon? What is the relation between the cost per gallon and the profit per gallon, *i.e.*, does a low cost per gallon always or even generally result in a high profit per gallon? Does the profit per gallon provide a reliable index of the total herd profit, *i.e.*, does a high profit per gallon always give a higher total profit than a lower profit per gallon? What are the principal factors which determine the total profit from a given herd over a given period? It is assumed, of course, that the fundamental object in milk-production, as in any other industry, is to obtain the maximum profit possible from the business as a whole; high milk-yields, low costs per gallon and high profits per gallon must be viewed ultimately in the clear light of the total herd profits which they produce.

While acting as Chief Costings Officer for Scotland under the Agricultural Costings Committee and latterly under the Board of Agriculture for Scotland, the writer was responsible for carrying out two separate investigations into the costs of milk-production, and results were obtained from about eighty farms scattered throughout Scotland. For the present purpose, however, it will be sufficient to discuss the results obtained for the year ended 14th May 1921 on twenty farms[1] situated in the west and south-west. All the farms were wholly or almost wholly devoted to milk-production for sale (except one cheese-making farm) and the object was to maintain a supply of milk all the year round; in all cases, the cows were bred on the farm (except for an occasional purchase) and milk records were kept on thirteen of the twenty farms. These farms were therefore managed on *approximately* the same general system; it would be obviously futile to compare results from, say, a town dairy with those from, say, a cheese-making farm where all the cows calved in the spring, for in such cases the basis of production is entirely different.

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[1] These twenty farms have not been selected in any way, but comprise all the farms in this district which were included in one of the two schemes.

The following table shows for each farm the average cost in pence per gallon of labour (production only), foods less manure, live stock account, general expenses, interest on capital and management, together with the total net cost* per gallon, the average yield per cow-day (for all cows) and the total yield, the farms being arranged in order of cheapness per gallon.

SUMMARY OF AVERAGE COSTS OF MILK-PRODUCTION ON TWENTY FARMS OF THE SAME CLASS FOR THE YEAR ENDED 14TH MAY 1921.

Farm No.	Labour (Production only).	Foods, less Manure.	Live-Stock Account (*Dr.*).	General Expenses.	Interest on Capital.	Management.	Total Cost.	*Less* Live-Stock Account (*Cr.*).	Total Net Cost.	Average Yield per Cow-Day (all Cows).	Total Yield.
	D.	D.	D.	D.	I.	D.	D.	D	D.	Gals.	Gals.
36	3·83	14·06	...	·78	1·44	1·43	21·54	7·83	13·71	1·68	10,815
28	2·95	16·37	...	·71	1·44	·99	22·46	8·71	13·75	1·60	17,547½
49	3·20	12·19	...	·76	1·03	·81	17·99	3·81	14·18	1·94	19,226
34	5·00	15·16	...	1·15	1·46	1·06	23·83	9·60	14·23	1·73	14,791½
20	2·80	12·26	...	·94	1·05	1·01	18·96	3·76	14·30	1·93	15,355
50	1·96	10·34	...	1·08	·74	·78	14·90	·33	14·57	1·49	24,069½
46	2·05	12·83	...	·55	·82	·86	17·11	2·28	14·83	2·31	21,641½
11	2·81	9·08	·22	·70	1·08	1·11	15·00	...	15·00	1·73	22,438
1	2·13	11·93	..	1·67	1 21	1·03	17·97	2·85	15·12	1·73	36,150½
45	2·84	13·80	...	·50	1·06	·75	18·95	3·05	15·90	2·21	29,064½
37	2·63	15·05	...	·70	1·15	92	20·45	3·46	16·99	1·92	20,466¼
6	5·59	10·86	...	1·10	1·13	1·22	19·90	1·05	18·85	1·68	12,777
2	2·36	19·32	...	2·05	1.33	1·08	26·14	6·95	19·19	1·77	17,483
30	3·41	15·01	...	1·45	1·53	·80	22·20	2·58	19·62	1·76	23,537
4	4·19	17·14	...	·79	1·16	1·12	24·40	4·58	19·82	1·45	16,641½
19	5·41	16·89	...	·72	·95	·87	24·84	4·20	20·64	1·67	14,365½
7	4·59	24·31	..	·85	1·48	1·09	32·32	10·44	21·88	1·54	11,435
14	4·66	20·51	...	1·28	2·00	·93	29·38	7·48	21·90	1·70	26,963½
32	1·78	14·50	3·32	1·06	1·35	·88	22·89	...	22·89	1·72	42,273
35	3 93	18·40	...	·90	1·16	·95	25·34	1·94	23·40	1·93	23,012
All Farms.	3·15	14·71	...	1·02	1·24	·95	21·07	3·29	17·78	1·77	420,052¾

Note.—Average yield per cow-day (for cows in milk)=2·22 gallons.

It may be mentioned in passing that, after classification according to the general system of management and the period covered, the results shown by the other sixty farms are in accordance with those just given.

A few explanatory remarks are necessary regarding the basis of these results. First, the unit taken was the whole dairy stock—cows, bulls and young dairy stock—and not merely the milking herd. The chief reason for this is that on the regular dairy farm with a "breeding stock" (*i.e.*, where the milking herd is maintained by home-bred heifers or queys) it is impracticable for the farmer, without regular assistance, to keep separate and accurate costs for each of the various classes of dairy stock. In any case, economy in the rearing of the young stock is a factor of considerable direct importance in milk-production and it is impossible to look upon the disposal of the cast cows as being other than an essential part of the process of production. [For certain purposes, however, it is desirable to take out separate costs for the feeding of the cows].

"Labour" includes only that required in production, *i.e.*, excludes all delivery costs; work done by the farmer and members of his household is charged at current rates for hired labour of the same class. "Foods" include purchased foods—at cost prices delivered on the farm, home-grown crops—at average market prices on the farm, grazing—at estimated cost, and milk fed to calves—at 1s. 4d. per gallon in the summer and 2s. per gallon in the winter period. The dung produced was valued at an average price of 12s. per ton in the dung-heap.

"General expenses" include a share of the rent and rates on the farm buildings, maintenance of dairy equipment, coal, lighting-oil, soap, soda and cloths, veterinary attendance and medicines, insurances, milk-recording expenses, upkeep and running-expenses of milking-machine, expense of marketing live-stock, etc. "Interest on capital" is charged at the rate of 6 per cent. per annum on the capital value of the dairy live-stock and equipment, while "management" is charged on the basis of 1s. per cow per week, with a minimum of 20s. and a maximum of 60s. per week.

The "live-stock account" is made up on the following lines:—

Debits.	*Credits.*
To Valuation of all Dairy Stock at beginning of year.	By Sales of Dairy Stock during year.
" Purchases of Dairy Stock during year.	" Valuation of all Dairy Stock at end of year.

On farms of this class the balance of this account is generally a credit to the milk-production account. The average value per head of the 630 cows on these farms at the beginning of the year was £36, 14s. 11d., and of the 656 cows at the end of the year £36, 12s. 9d., or practically the same: the young dairy stock were valued at the same average rates per head for the different age-groups at the beginning and at the end of the year. It will be noticed that in this account allowance is automatically made for calves kept for rearing and for deaths.

The "average yield per cow-day" was calculated both on the basis of cows in milk and of all the cows, but for the present purpose the latter basis has been taken, so that the approximate average annual yield per cow can be found by multiplying the yield per cow-day by 365. The "total yield" includes not only milk sold but also milk given as a perquisite, fed to calves, used in the farm-house, etc.

The variations from farm to farm shown in the above table may appear remarkable, but they are not at all surprising. It is evident that the relation between the average yield per cow-day and the final net farm cost per gallon is highly indeterminate, and although the number of cases is small there is nothing in the nature of these results (or of those from the other sixty farms) to indicate that they are other than typical. The farm cost per gallon varies from 13·71d. on farm 36, and 13·75d. on farm 28, up to 22·89d. on farm 32 and 23·4d. on farm 35, with an average of 17·78d.; farms 36 and 28 had average yields per cow-day of only 1·68 and 1·6 gallons respectively, whereas farm 32 had a yield of 1·72 and farm 35 one of 1·93 gallons, the average yield being 1·77 gallons per cow-day. It should be noted, however, that farms 46, 45, 49 and 20, which had the highest average yields, had each a cost per gallon considerably under the average, thus indicating that the yield is one important factor in determining the cost per gallon.

The relation between the milk-yield per cow-day and the cost per gallon for each farm is shown at a glance in the following graph (p. 385), the farms in this case being arranged in order of their average milk-yield, commencing with the highest. It will be noticed that while there is a distinct tendency for the milk-yields to be grouped closely around the average milk-yield, no such tendency can be observed in the costs per gallon.

How then can these results be explained? As regards general expenses, interest and management charges, the variations are relatively insignificant, although they cannot be altogether ignored. It may be pointed out that farms 1, 2 and 30, on which the general expenses are well above the average, have milking-machines; farm 32 also has a milking-machine, but an exceptionally large herd. We are left with labour, foods and the live-stock account.

The average cost of production-labour per gallon was 3·15d., but there is a variation of from 1·78d. to 5·59d. Some light is thrown upon the factors which determine the labour-cost per gallon if we take out the ten farms having a milk-yield of from 1·67 to 1·77 gallons per cow-day and arrange them as shown below, *i.e.*, we eliminate, to a considerable extent, the effect of yield upon the labour-cost—

Farm Number.	Average Number of Cows.	Total Milk-Yield (in thousands of gallons).	Cost of Labour per gallon.	Average Yield per Cow-Day.
			Pence.	Gallons.
36	18	10·8	3·83	1·68 *
6	21	12·8	5·59	1·68
19	23	14·4	5·41	1·67
34	24	14·8	5·00	1·73
2*	27	17·5	2·36	1·77
11	36	22·4	2·81	1·73
30*	37	23·5	3·41	1·76
14	44	27·0	4·66	1·70
1*	57	36·2	2·13	1·73
32*	68	42·3	1·78	1·72

Milking-machine used.

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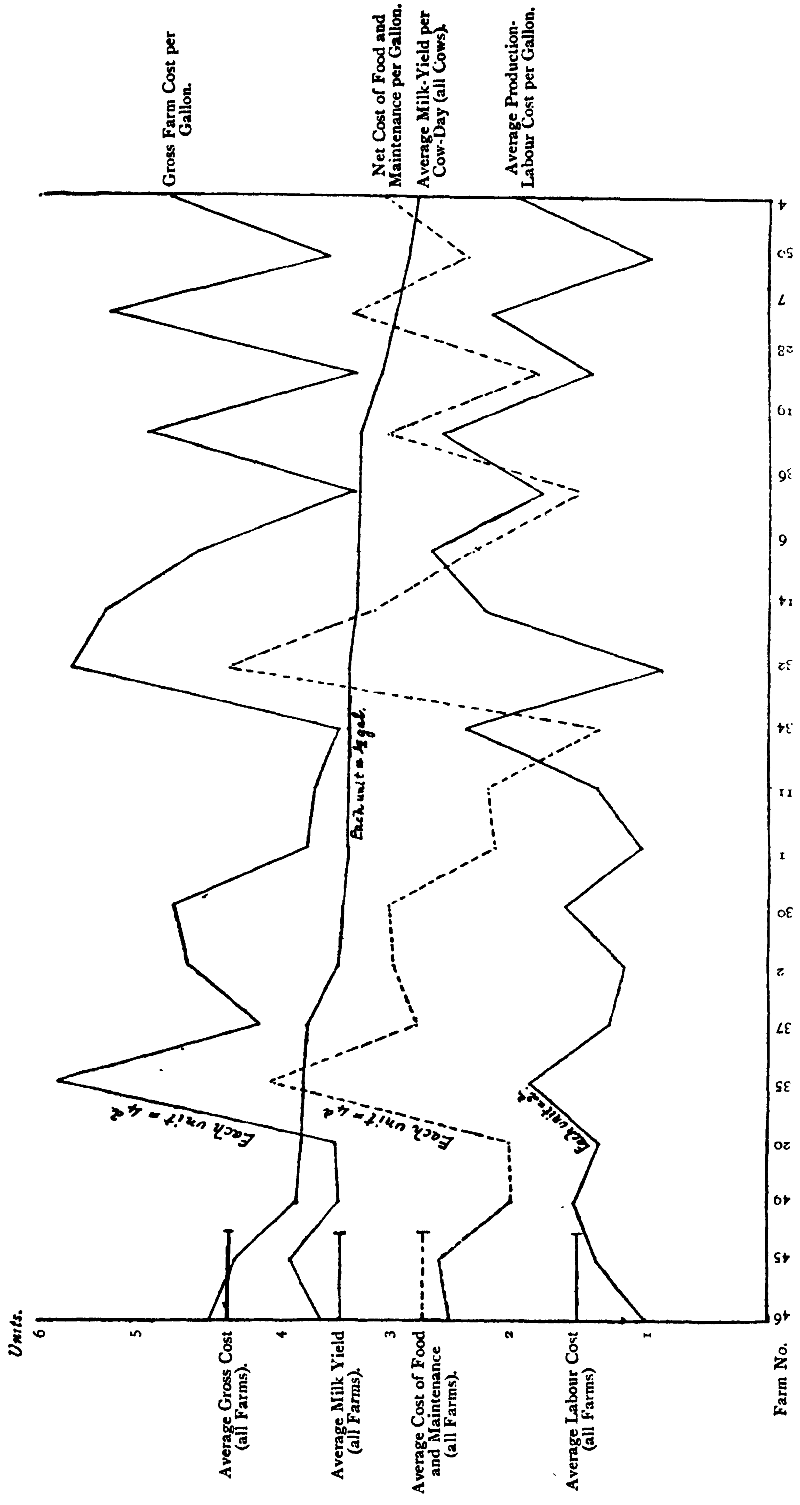
Units.
6
5
4
3
2
1
Average Gross Cost (all Farms).
Average Milk Yield (all Farms).
Average Cost of Food and Maintenance (all Farms).
Average Labour Cost (all Farms)
Farm No.
46
45
49
20
35
37
2
30
1
11
34
32
14
6
36
19
28
7
50
4
Gross Farm Cost per Gallon.
Net Cost of Food and Maintenance per Gallon.
Average Milk-Yield per Cow-Day (all Cows).
Average Production-Labour Cost per Gallon.
Each unit = 4d
Each unit = 4d
Each unit = ½ gal.
Each unit = 2d

It will be seen that the labour-cost per gallon tends to fall as the size of the herd increases. When it is pointed out that farms 1, 2, 30 and 32 have milking-machines, that the dairy stock on farm 14 was partly pedigreed, and more that the average of young stock were kept, and that farm 36 was chiefly worked by women labour, it will be recognised that the relation shown between the size of the herd and the labour-cost per gallon is as close as can be expected—since the other factors involved are not exactly the same in every case.

On the smaller farms it would appear that, although much of the work was done by women, the workers were not very efficiently employed—however efficient they may have been while actually working—whereas the lowest costs per gallon are found on the farms with large herds where the working of the dairy is let to a family party at so much per cow, etc., and where the milking is chiefly done by machine (farms 1 and 32).

Obviously, the relative labour-cost per gallon also depends upon the rates of payment, the hours of work, the efficiency of the workers, etc., as well as upon the suitability of the buildings, the number of young stock kept, the methods of feeding, the degree of cleanliness observed in the byres and for the cows, etc. For example, on farm 14 the stock were kept at two different premises, and extra care was taken in the matter of cleanliness, while on farm 32 some of the young stock were wintered outside on another farm.

After making due allowance for all these factors the evidence is clear that *the labour-cost per gallon is more closely related to the size of the herd than to the milk-yield per cow-day.*

We come now to what is the crux of the whole matter, viz., the cost of foods (less manure), and it may be said at once that this factor cannot be usefully discussed apart from the live-stock account. In fact, we can look upon the dairy stock as a plant for producing milk, just as a steam boiler and engine constitute a plant for producing power. The fundamental object of the farmer must be to maintain, or to increase, the economic efficiency of this plant. He will, of course, lay great stress upon the quantity, quality and cost of the foods consumed by the cows, but he will not forget that much also depends upon the conditions under which the foods are used, the cost of replacing worn-out or "damaged" cows, the incidence of the price of milk upon the degree to which heavy feeding can be economically practised, and so on.

Hence, we can combine the feeding costs with the credit (or debit) from the live stock account, and call the result the net cost of feeding and maintaining the dairy stock or milking plant. The results are plotted on the graph given above (p. 385) which shows that, with one or two exceptions, the curve follows closely that for the total cost per gallon.

Now, if we take out the ten farms having approximately the same average milk-yields we get the following results :—

Farm No.	Average Milk-Yield per Cow-Day.	Total Net Cost per Gallon.	Net Cost of Feeding and Maintenance per Gallon.	Net Cost of Foods per Gallon.
	Gallons.	*Pence.*	*Pence.*	*Pence.*
36	1·68	13·71	6·23	14·06
34	1·73	14·23	5·56	15·16
11	1·73	15·00	9·30	9·08
1	1·73	15·12	9·08	11·93
6	1.68	18·85	9·81	10·86
2	1·77	19·19	12·37	19·32
30	1·76	19·62	12·43	15·01
19	1·67	20·64	12·69	16·89
14	1·70	21·90	13·03	20·51
32	1·72	22·89	17·82	14·50

It is clear that *the final cost per gallon follows the net cost of feeding and maintaining the herd rather than the cost of feeding alone.*

It will probably be urged that these results are of little value since they give no clue as to which method of feeding the cows has the highest economic efficiency. The answer must be, first, that separate costs for the feeding of cows are not available ; second, even if they were, that conclusions based upon the feeding of the cows only would be much less reliable than those based upon both the feeding and the maintenance of the milking herd ; and third, that the goal of the farmer is not minimum feeding costs per gallon but maximum total profits from the dairy stock as a whole.

It may here be pointed out that, on the basis given above, the average costs per gallon for the twenty farms may be summarised as follows :—

	Pence per Gallon.	Percentage of Total.
Labour (production only) .	3·15	17·7
Feeding and Maintenance .	11·42	64·2
General Expenses . .	1·02	5·7
Interest on Capital . .	1·24	7·0
Management . . .	·95	5·4
Total . .	17·78	100·0

Coming back, however, to the relation between the cost per gallon and the average yield per cow, per day or per annum, a few examples may now be given to illustrate why the connection is bound to be a loose one.

(1) Farmer A has a large herd, buys his foods in bulk and is fortunate in buying when prices are at their lowest ; farmer B has a small herd and buys his foods in small quantities as required, with the result that on the average they cost him about £2 per ton

more than farmer A. Here the disturbing factor is the price of the purchased feeding—a factor continually in operation.

(2) On farm C, the season has not been favourable to its particular class of soil and the crops are comparatively poor whereas on farm D excellent crops have been obtained. Hence, no matter whether the crops are charged at cost or at market price, the feeding bill will be higher on farm C than on farm D and another disturbing factor is introduced in the shape of the weather and its effects upon the crop-yields. The variable effect of the weather upon the pasture on different farms is also a factor of great importance as it has been conclusively shown that a plentiful supply of good grazing at a moderate cost is the predominating factor in securing economy in milk-production during the summer months.

(3) Farmer E keeps a class of comparatively young cows and makes a point of selling several each year while they are still in their prime—a practice which is often condemned as being necessarily short-sighted; while farmer F sells only old or unsound cows. The former will probably have the lower average milk-yield, but this may be more than balanced by the high credit obtained in the live-stock account and in the end farmer E may have the lower cost per gallon.

(4) Farmer G may sell his milk wholesale whereas farmer H may retail it at a much higher price per gallon. Hence, farmer H may be content with a lower average milk-yield and a higher cost per gallon than what are necessary to ensure a profit to farmer G, *i.e.*, the disturbing factor is the value of the product.

(5) Labour costs vary from a variety of causes. (*See* p. 386).

Numerous other examples might be given but these must suffice.

Consider now the relation between the production cost per gallon and the financial result (net profit or loss). The table given below (p.389) summarises the results from the twenty farms already discussed, the farms being arranged in order of production-cost per gallon but divided into two groups as shown.

The two new factors introduced here are the *cost of delivery* and the *value of the product*. The former has been calculated over the *total* milk produced and includes man and horse labour costs, motor haulage and railway carriage; the latter has been obtained by adding the total price of the milk sold to the value of the milk used on the farm and in the farmhouse—reckoned at 1s. 4d. per gallon in the summer and 2s. per gallon in the winter period (but no allowance has been made for possible bad debts or deductions for milk going sour, etc.). The average number of cows in the herd has been found by dividing the total number of cow-weeks by 52.

The upper part of this table comprises sixteen farms from which the milk was sold wholesale either direct to a retailer, to a wholesaler or to a "creamery"; the lower part includes three farms on which the milk sold was retailed (wholly or mainly) by the farmers themselves and one farm on which about one-half was sold wholesale and the other half was made into cheese.

SUMMARY OF AVERAGE COSTS OF MILK PRODUCTION, MILK-YIELDS, MILK PRICES AND PROFITS ON TWENTY FARMS OF THE SAME CLASS FOR THE YEAR ENDED 14TH MAY 1921.

Farm No.	Average Yield per Cow-Day (all cows)	Average Cost per Gallon.			Average Price per Gallon.	Net Profit.		Gross Profit.*		Average No. of Cows in Herd.
		Production.	Delivery.	Total.		Per Gallon.	Per Cow.	Per Gallon.	Per Cow.	
	Gals.	D.	D.	D.	D.	D.	£	D.	£	
36	1.68	13·71	1·07	14·78	23·34	8·56	21·4	11·43	28·7	18
49	1·94	14·18	2·09	16·27	24·15	7·88	23·4	9·72	28·8	27
34	1·73	14·23	1·07	15·30	22·23	6·93	17·8	9·45	24·3	24
20	1·93	14·30	1·59	15·89	23·89	8·00	23·3	10·06	29·3	22
50	1·49	14·57	1·74	16·31	23·14	6·83	15·6	8·35	19·0	44
46	2·31	14·83	·62	15·45	23·61	8·16	28·3	9·84	34·1	26
1	1·73	15·12	2·06	17·18	23·45	6·27	16·6	8·51	22·5	57
45	2·21	15·90	·46	16·36	23·59	7·23	24·3	9·04	30·4	36
37	1·92	16·99	·40	17·39	23·44	6·05	17·8	8·12	23·9	29
6	1·68	18·85	1·54	20·39	24·54	4·15	10·5	6·50	16·5	21
2	1·77	19·19	1·82	21·01	24·71	3·70	10·0	6·11	16·6	27
30	1·76	19·62	1·27	20·89	22·30	1·41	3·7	3·74	9·9	37
4	1·45	19·82	1·59	21·41	24·65	3·24	7·0	5·52	12·0	32
19	1·67	20·64	·92	21·56	26·06	4·50	11·7	6·32	16·4	23
7	1·54	21·88	1·72	23·60	24·35	·75	1·8	3·32	8·0	20
14	1·70	21·90	·92	22·82	22·18	–·64	–1·6	2·29	5·8	44
16 Farms	1·77	17·10	1·30	18·40	23·59	5·19	14·0	7·34	19·8	30½
28	1·60	13·75	2·35	16·10	30·91	14·81	36·1	17·24	42·0	30
11	1·73	15·00	2·24	17·24	32·56	15·32	39·8	17·51	45·5	36
32	1·72	22·89	·46	23·35	19·06	–4·29	–11·1	–2·06	–5·3	68
35	1·93	23·40	1·72	25·12	32·61	7·49	21·8	9·60	27·9	33
All Farms	1·77	17·78	1·33	19·11	24·41	5·30	14·2	7·49	20·0	33

* *i.e.*, Net profit *plus* interest on capital and management charges.
Note. Minus (–) signs indicate losses.

In the discussion of these results, it is first necessary to decide whether the final judgment regarding the financial result is to be based upon the net profit per gallon or upon the net profit per cow, and a moment's consideration will show that the latter basis is the more trustworthy, since it brings more fully into account the relative effects of high, average and low milk-yields. Now it is clear that the net profit per cow may be obtained in various ways, being the resultant of three variables, viz.—(1) the yield per cow, (2) the cost per gallon and (3) the value of the product. This is shown by the following pairs of farms.

Farms 36 and 35 have about the same net profit per cow but in the former case it is the result of a low yield, a low cost per gallon and an average product value, whereas in the latter it is due to a high product value combined with a high yield and a high cost per gallon; and although the net profit per gallon is nearly a penny more on farm 36 the net profit per cow, on account of the lower yield, is about 8s. less. Similarly farm 34; in spite of the lower yield, has a cost per gallon of twopence less than farm 37; about one-half of this advantage is lost because of the higher product value on farm 37, but the final result is the same net profit per cow.

Farm No.	Yield per Cow-Day.	Total Cost per Gallon.	Price per Gallon.	Net Profit per Gallon.	Net Profit per Cow.
	Gallons.	D.	D.	D.	£
36	1·68	14·78	23·34	8·56	21·4
35	1·93	25·12	32·61	7·49	21·8
34	1·73	15·30	22·23	6·93	17·8
37	1·92	17·39	23·34	6·05	17·8

Farms 1 and 37 further illustrate the importance of having a high yield per cow. These farms have practically the same product value; farm 1 has an advantage of one-farthing per gallon as regards net profit per gallon, whereas the net profit per per cow is fully £1 greater on farm 37, the latter having a yield of 1·92 gallons per cow-day compared with only 1·73 in the case of farm 1.

Again, a comparison of the results from farms 6 and 19 exemplifies the importance of a high product-value. These farms have practically the same milk yield; milk produced on farm 6 costs fully one penny per gallon less than on farm 19, but, on account of the higher product-value, farm 19 shows a net profit per gallon of one-third of a penny and a net profit per cow of fully £1 more than farm 6. Farms 20 and 35 illustrate the same point.

Lastly, farms 36 and 50 show that even with low yields and average product-values, comparatively high profits per cow may be attained by means of low costs of production.

Particular attention may be called to the high profits per cow on farms 46, 45, 49, 20 and 37, on each of which the milk-yield is over or approaches to 2 gallons per cow-day, *i.e.* to over 700 gallons per cow per annum.

In general it may be noted that (other things being equal in each case), with an average yield of 600 gallons per cow per annum, a difference of 2d. per gallon in the cost per gallon *or* in the value of the product will cause a difference of £5 in the profit per cow, while with milk at 2s. per gallon a difference of 50 gallons in the average yield per cow per annum will cause a similar difference in the profit per cow.

It is now possible to formulate a conclusion of fundamental importance in cost of production studies, viz., that a comparison of costs per gallon on various farms is likely to prove highly misleading as to the relative economic efficiency* of the management on these farms, since it disregards entirely the product-value factor and does not make full allowance for the milk-yield factor, and that a similar comparison based upon the relative net profits per gallon may also prove misleading, though to a less extent, since it also does not make full allowance for the yield factor; whereas *a comparison based upon net profits per cow gives proper weight to each of the three important factors—yield, cost per gallon, and product-value*—and is therefore by far the most reliable. It is unfortunate that in the few cost investigations which have been made in this country the work has not usually been taken beyond the cost per gallon (or other unit) stage; only one side of the account has been completed, whereas it is a mere truism that the efficiency of any productive process must be judged not so much either by the cost of production or by the value of the product as by the relation which the former bears to the latter, the relation of the net financial return to the capital invested, etc.

It must be emphasised that there should be no confusion between the point of view of the individual farmer and that of the economist. The former is primarily concerned with his own particular case; the latter with the general conditions within the milk-production industry. The lesson for the individual producer is perfectly plain. Under his own given set of conditions of production and of sale, he should, by means of systematic feeding and milk-production records kept over a series of years, ascertain the part which each of the various factors plays in determining the cost per gallon, the net profit per gallon, and the net profit per cow. Without milk records, the farmer who is seeking to improve the average milk-yield of his herd is working more or less in the dark; without cost records and accounts he is equally in the dark in attempting to increase his net financial returns.

But the individual farmer's incentive towards improvement of his own results will be derived to a certain extent from the knowledge that other farmers, working under similar conditions, are doing better than he is. Herein lies the value of comparing the results from different farms. Such comparisons, however, must be made upon a proper basis, and they will be all the more valid and useful if based upon results from the same farms over a period of from four to five years. In fact, until such data are available, it will be impossible to arrive at any definite conclusions regarding the relative economic efficiency of different farmers, of different systems of production, of different methods of disposing of the milk, and so on.

Consideration of space forbids more than a brief reference to the question which at once arises out of the above conclusions: What is the most reliable index of the relative economic efficiency of individual cows in the same herd?

It is now generally accepted that systematic milk records are essential in determining the relative *milk-producing* powers of the individual cows in the herd, but do such records also provide a reliable basis for answering the still more important question: which cows have yielded the highest net profits and which the lowest? If not, are cost records sufficient, or must we rely only upon individual cow cost accounts?

In general, it may be said that for this purpose the soundness of the milk record basis depends chiefly upon the relation between the yield of milk and its value when put upon the market. If the value is exactly in proportion to the yield then the basis would appear to be reasonably safe, but otherwise it may be more or less misleading.

For example, in all cases where the value of the milk depends upon its "quality" (judged by the percentage of butter-fat), as in cheese and butter making, this factor must be allowed for in the comparison, *i.e.*, a cow giving 600 gallons of milk of 3·6 per cent. butter-fat would be rated higher than one giving an equal quantity of only 3·2 per cent. milk.

On the other hand, where the value of the milk bears no relation to its quality (percentage of fat), after a certain minimum standard has been reached, a cow giving 600 gallons of 4 per cent. milk may be less profitable than another cow giving a like quantity of 3·5 per cent. milk, since the former milk because of its higher quality may cost more to produce.

Further, the influence of the time of calving upon the milk-yield, the cost per gallon and the value of the product must not be ignored. A cow calving in the autumn may produce 700 gallons of milk during her lactation, while an equally good cow calving in the spring may give only 600 gallons. Is the milk-yield a safe criterion of the net financial return from these two cows? Obviously it is not; the real test is the extent to which the extra 100 gallons of milk from the autumn calver, together with, it may be, a higher average price per gallon, balances the heavier costs of feeding, housing, attending, etc., *i.e.* complete cost accounts for the two cows are necessary.

These remarks are offered tentatively not with any desire to disparage the necessity and value of milk records in the selection and grading up of a highly profitable dairy herd, but merely as a reminder that maximum milk-yield and maximum net profit per cow do not always go together, and that under many circumstances no elaborate calculations are necessary to show that the net profit per cow is not entirely dependent upon the milk-yield.

Acknowledgment is due to the Board of Agriculture for Scotland for the use of original and unpublished data which have been required in the preparation of the tables here given.

THE REPORT OF THE INTER-DEPARTMENTAL COMMITTEE ON MILK.

THE Committee was appointed in April 1920, with the following terms of reference:—

"To report upon the laws, regulations and procedure under which milk is sold in Scotland, and to recommend such alterations as may be thought necessary.

"The special points to which the attention of the Committee is directed are:—

(1) The presumptive or legal standard for milk;
(2) The question of warranty of composition;
(3) Methods of sampling and of making analyses;
(4) Court of trial and the incidence of expenses.

"Any other questions arising from the above."

Their report,[1] which has just been issued, is of interest to every person who disposes of milk for sale, whether wholesale or by retail.

Before proceeding to analyse the contents of the report it is to be observed, in connection with so controversial a subject as the milk standard, that the members of the Committee were strongly representative of the various interests concerned. Three well-known agriculturists, Dr Douglas of Auchlochan, Mr George Buchanan and Mr John Findlay sat on the Committee. Mr James Stirling of the Glasgow Dairy Company (who was a witness before the Departmental Committee of 1900-1901) and Mr William Ramsay represented the retail trade, and the wholesale trade was represented by Mr Duncan A. Macleod, Secretary of the Glasgow Wholesale Dairymen's Association. Sir Robert B. Greig (who joined the Committee at a later date) and Mr James Wood represented the Board of Agriculture. Sir Leslie Mackenzie (the chairman), Miss Ritson and Lieut.-Col. Leighton represented the Scottish Board of Health. Dr Tocher is a public analyst and consulting chemist to the Highland and Agricultural Society, and Mr Thomas Bishop is a sampling officer. The Countess of Mar and Kellie watched over the interests of mothers and children, while Mr W. E. Smith, of the Dairy Supply Company, Limited, was called to the Committee as an independent dairy expert.

The Committee was appointed because of representations from three principal sources. In 1918 the Scottish Chamber of Agriculture asked for an enquiry into the whole question of the milk standard. The National Farmers' Union in 1919 made the same request, and when the Committee on the Production and Distribution of Milk in their report (Cmd. 483) also pressed for revision of the existing Regulations, it was apparent that the time had come for reconsideration of the standard for milk and all that it involved.

Fifty-two witnesses, representing every interest, were examined by the Committee, and their verbatim evidence has been published in a separate volume, price 30s. net.

The first section of the report is introductory and historical. The second deals with the constituent parts of milk and their functions in nutrition. The Committee have placed this section in the prominent position which the importance of the subject deserves, and it is to be hoped that practical men, in their natural haste to reach the practical arguments and recommendations, will not omit to give this portion a careful scrutiny. It is written plainly, in the endeavour to show the public and those engaged in the milk industry the full importance of milk. It is often forgotten that butter fat is only one of many valuable constituent parts of milk: the bodies of children are nourished and developed on the proteins of milk; their bones are built up from the mineral matter; and their bodily warmth and energy are derived from lactose or milk sugar, as well as from fat. While, therefore, the commercial value of milk often depends almost entirely on its butter fat, the value of milk to the country as a whole depends as much on the other constituent parts. This section also contains an account of the vitamins associated with milk.

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[1] Obtainable from H.M. Stationery Office, 23 Forth Street, Edinburgh, direct, or through any bookseller. Price 3s.

Section III. of the Report is a summary of the existing law governing the sale of milk in Scotland. Particular attention is devoted to the case of Scott *v.* Jack, which was decided in the High Court of Justiciary in July 1912, and which, the Committee say, caused the presumptive standard to enter on a new stage. In that case the Sheriff put the question to the High Court "whether milk containing only 2·57 per cent. of milk fat, and 7·51 per cent. of solids other than fat—the deficiency being due to a method of feeding purposely adopted to produce quantity irrespective of quality—might be genuine milk." The Committee state that the hypothesis that feeding can reduce the quality of milk over a considerable period is now discredited, but the unanimous decision of the seven judges that the milk might be genuine has materially changed the legal aspect of milk samples found below the standard. Gradually the implications of the case have become known throughout the country, and it is now common for milk vendors (especially producer-retailers) to bring their servants to Court to swear that they did not adulterate milk, and a discharge usually follows.

"It can readily be understood," the Committee say, "that unscrupulous persons may offer such 'proof' that the milk which they have sold below the standard is genuine, and in the absence of evidence to the contrary may be acquitted, although actual and persistent adulteration of milk has taken place."

Section IV. is devoted to the evidence taken in regard to the actual quality of milk. After enumerating the various causes that lead in practice to the sale of milk low in fat, the Committee state that probably the commonest cause of deficiency in genuine milk is the long interval before the morning milking. "It is possible," they add, "that milking twice a day, with as nearly regular intervals as could be obtained, would eliminate all or nearly all these cases."

It appears that in all the records of the Milk Records Association there has never been a single occasion on which the daily average of the milk from a herd contained less than 3 per cent. of fat. Various witnesses connected with the milk industry, with daily experience of analyses, declared that milk with at least 3 per cent. of butter fat could be obtained from any farm at any time of the year. A producer in the south stated that the mixed milk of a herd of twenty cows could not fall below 3 per cent. of fat. Other witnesses of experience gave evidence to the same effect.

Three representatives of creameries, whose minimum requirements are 3·2, 3·3 and 3·5 per cent. of fat, stated that when milk from any farm fell below their requirements they informed the producer concerned of the facts, and desired him to improve the quality. In most cases they found that the simple intimation was sufficient to secure the improvement desired.

In regard to solids not fat, the general impression the Committee received was that, in practice, if the fat content of milk was satisfactory the solids not fat usually reached the figure of 8·5 per cent.

Section V. deals with the case for and against the presumptive standard. It is pointed out, and proof is adduced, that the standard of 3 per cent. butter fat, and 8·5 per cent. other solids (and not the presumption of guilt in cases of deficiency) has actually raised the quality of milk sold throughout Scotland. Further, in the most populous parts of Scotland this presumption was not even strictly applied, for it was ascertained that the authorities did not usually raise legal proceedings unless a sample of milk was substantially below the figures of the standard.

The case against the presumptive standard, as detailed on pages 33 to 36 of the Report, leads up to the list of witnesses who favoured a legal standard, and the list of those who favoured the presumptive standard. The number of those who desired a legal standard was twenty-five, including prominent agriculturists, as well as officials and retailers. The number of witnesses who desired the continuance of the presumptive standard was eleven. Most of the latter, however, suggested modifications of the existing arrangements, and appeared to assume that under a legal standard nothing could be done to safeguard a producer or vendor who sold milk below the figure of the standard, and who had not tampered with it in any way.

Sections VI. and VII. contain the principal recommendations of the Committee. These are :—

1. *The Minimum Limit.*

A new system of administration is necessary in regard to the sale of milk.

(*a*) There should be a legal minimum limit for butter fat and solids not fat in milk. Meantime, the figures of this limit should not be less than 3 per cent. of fat and 8·5 per cent. other solids.

(*b*) There should be a legal minimum limit for skimmed and separated milk of 8·7 per cent. solids other than fat.

(*c*) There should be legal minimum limits :—

(1) For ordinary cream of 10 per cent. butter fat, and

(2) For double cream of 40 per cent. butter fat.

(*d*) There should be a legal minimum limit of 5 per cent. solids not fat in butter milk.

The figures of the limit for milk should be determined by order of the Central Department, which should have power to revoke such an order and impose a new one. They should also define milk.

Regardless of the minimum limit the addition of water to milk (including skimmed and separated milk) should remain an offence.

The Central Department should be empowered, after due enquiry, to fix local minimum limits for milk.

The addition of thickening matter to cream should be definitely prohibited.

2. *The Administration of the Legal Minimum Limit.*

All milk vendors should be registered in the manner contemplated by the Milk and Dairies (Scotland) Act, 1914, and the provisions as to removal of unsuitable persons from the register should apply to offences against the minimum limit.

The milk of every producer, wholesale dealer and retailer should be sampled regularly and frequently, and the persons concerned should receive, at the earliest possible date after sampling, a statement of the figures obtained by the public analyst.

The Local Authority should conduct sampling of milk at the premises where it is produced, and the producer and any other local authorities concerned should be supplied with the results of analysis.

The system of official milk records deserves the strongest support. It is part of the producer's business to make himself generally acquainted with the quality of the milk he supplies to the public.

It should be the producer's duty to see that his milk is properly mixed in order to supply milk that conforms with the minimum limit. Accordingly, each can of milk consigned by a producer should contain milk with butter fat up to the limit.

For the purpose of assisting wholesale dealers and retailers, it should be competent for the sampling officer, when requested, to take a sample of milk and to furnish the vendor with the figures of analysis. It should be an offence for any vendor to use these figures in a way which is intended to prejudice any other person, and in order that this method of assistance may not be unduly strained, local authorities should have the option of charging a modified fee.

It is the duty of the retailer to see that his customers receive a fair sample of the milk which he retails.

The sampling officer, by enquiry and advice, should make certain that each person in charge of milk is aware of what is expected of him.

When an official sample is found to contain less than the proportion of constituent parts set out above, the sampling officer or administrative officer should investigate the circumstances, and should use every endeavour to ascertain the cause of the deficiency.

The first time an official sample is found below the minimum limit there should be a warning, unless the Local Authority are satisfied that it is a case of adulteration.

The milk of any vendor whose milk has been found below the limit should be sampled more frequently.

The Local Authority should have power to withdraw the certificate of registration after a person has been convicted in Court four times. In the case of multiple shops this should only apply to the shop concerned.

In order to safeguard the interests of milk producers and vendors, a person whose certificate of registration is withdrawn should be enabled to appeal to the Sheriff, but it should not be possible to evade the law by removing from one area into another.

There should be one Central Department dealing with the administration in regard to milk, and this should be the Scottish Board of Health. Where necessary the concurrence of the Board of Agriculture for Scotland to the action of the Central Department should be obtained.

Section VIII. discusses the warranty. Under a legal minimum limit the warranty ceases to be a defence. But, on the whole, it was not often supplied to small retailers, who had most need of it, but in whose hands it was a grave danger to the supplier.

Section IX. is devoted to the important subject of sampling. Bulking and bottling are strongly recommended as likely to provide samples above the limit; deputy sampling and test sampling are approved. Milk cans should be sealed, and sampling at railway stations should be abolished. In place of this method (*a*) the producer's milk should be sampled before it leaves his control, and (*b*) where it is necessary to sample the producer's milk on delivery to the consignee, it should be sampled in the latter's premises, and the seal should be broken by the sampling officer in presence of an assistant of his own and of the consignee or of his representative. All milk vessels should be labelled to show what they contain.

Retail sampling appears to have been carefully considered, and precautions are recommended for the protection of retailers. It is proposed also that the Central Department should make separate regulations dealing with the sampling of the milk of producers and of retailers.

Section X. deals with methods of analysis. In order to meet the wishes of vendors it is proposed that the public analyst shall in future *certify* only the figures of his analysis. Any observations he may have to make "based on his experience, as to the extent or character of any deficiency or adulteration, which might exonerate the vendor, or which would assist the Local Authority in the administration of the law" are to be added below his certificate.

The public analyst is to return the results of his analysis to the sampling officer within ten days of receipt of the sample, and a copy of the certificate is to be furnished within fourteen days to the person from whom the sample was taken.

In cases where the third portion of the sample is sent to the

Government chemist for analysis a general statement of the nature of the deficiency or alleged adulteration is to be supplied, but the figures obtained by the public analyst are not to be disclosed.

In Section XI. the Committee recommend that the jurisdiction of magistrates should be abolished, and that all milk cases should be tried before the Sheriff.

There has been a tendency of late years to place all prosecutions, conducted in the public interest, in the hands of the procurator-fiscal. When the latter is a part-time officer, however, it might happen that in one case he would prosecute in the public interest, and in another case he might be found acting on behalf of the defence. Accordingly, it is recommended that the existing system, whereby the person causing the analysis to be made may also initiate proceedings, should be continued.

In England, expenses may be granted by the Court in milk cases, either to a successful prosecutor or to a successful defender, and the Committee defer to the general desire that Scotland should fall into line.

Other miscellaneous recommendations are that there should be a separate statute dealing with the sale of milk, thus detaching milk entirely from the Sale of Food and Drugs Acts; that "the appeal to the herd," if carried out within seven days after an official sample is taken, should be regarded as evidence in any case of adulteration; that producers should be paid, as far as possible (but without compulsion), on a butter-fat basis; that colouring should be prohibited; that the sale of reconstituted milk should be regulated; that there should be as little delay as possible in bringing the Milk and Dairies (Scotland) Act, 1914, into operation, and that propaganda work, in which farmers and dairymen ought to assist, should be undertaken in order to impress on the public the value of a plentiful supply of clean milk.

The Report is signed by fourteen out of the fifteen members, and six of the members have reservations on points of detail. Mr John Findlay, however, has disagreed on fundamental points with the remainder of the Committee, and presents a Report in which he sets forth two separate schemes.

In his first scheme Mr Findlay recommends the abolition of the presumption of guilt, and though he proposes a standard of 11·5 per cent. total solids, 3·25 per cent. of which must be fat, he suggests no measures for its enforcement. The extent to which he applies this standard is as follows:—

(*a*) Ths average figure of the analyses of samples of morning, noon and evening milk, is to be intimated to the vendor, who is to be subject to a fine or imprisonment if this average figure is not brought to the notice of his customers.

(*b*) In any case where there is actual or circumstantial proof of adulteration of milk, the Local Authority are to be empowered to prosecute.

"If after a fair and reasonable trial, the above scheme is found to be impracticable," Mr Findlay favours a continuance of the present presumptive standards, provided they are amended in several respects.

Some time ago the Committee authorised an investigation into samples of the milk of a number of cows throughout Scotland, and 726 samples were taken by the official sampling officers. These samples were analysed by Dr Tocher and his staff, assisted by Dr Orr of the Rowett Research Institute and his staff. The proportions of casein, albumen, globulin, lactose, fat and mineral matter were ascertained in each case, and, besides the ordinary methods of analysis, the immersion refractometer and the freezing-point test were used in the investigations. The results of this enquiry, prepared by Dr Tocher, will be issued by H.M. Stationery Office in due course.

THE ALLOTMENTS (SCOTLAND) ACT, 1922.

THE Allotments (Scotland) Act, 1922, became law on 4th August. The passing of this measure marks an important and interesting stage in the progress made by the allotment movement in recent years, particularly since the outbreak of the war. It may not, therefore, be inappropriate, before reviewing the provisions of the Act, to refer first to previous legislation on the subject, to the means by which the movement was encouraged by the Government during the war when food supplies were dangerously short, and to the circumstances which led to the passing of the Act.

Prior to the war the principal statute governing the provision of allotments in Scotland was the Allotments (Scotland) Act, 1892. It conferred on Town Councils and County Councils the power to acquire land, by purchase or leasing, for allotments for the labouring population. Parliament provided no funds to facilitate the carrying out of the Act, and the procedure laid down was complicated and expensive. It was necessary for the local authority, where suitable land could not be acquired on reasonable terms, to proceed by way of Provisional Order requiring confirmation by Parliament. Few local authorities attempted to use the Act, and it had little effect in securing an increase in the number of allotments in the country. Again, under Part IV. of the Local Government (Scotland) Act, 1894, Parish Councils were empowered to take land on lease for allotments, or to a limited extent for common pasture. The effect of this Act, in so far as it related to allotments, was no wider than that of its predecessor

During the war the number of allotments particularly in urban areas greatly increased. With the object of maintaining the home-grown food supply of the country at the highest possible level, an appeal was made by the Government, and powers were given to the Departments of Agriculture in Scotland and England under Defence of the Realm Regulation 2L, to enter on land with a view to cultivating it or using it for the keeping and breeding of live stock, poultry or bees, or arranging for its cultivation or use. The Board of Agriculture for Scotland delegated their powers under the Regulation to Town Councils in urban areas under special Cultivation of Lands Orders issued in 1917 and 1918, while Parish Councils were encouraged to co-operate with the Board in providing applicants with allotments. Local authorities were also authorised to utilise for allotments lands of which they were owners or occupiers, such as public parks and open spaces, recreation grounds and the like. As is well known, a whole-hearted response to the Government's appeal was made by all classes of the community, and large numbers of new allotments were created. The total number of allotments in Scotland in 1914 may be set down roughly as between two or three thousand of a total extent of between two and three hundred acres. By the end of 1918 the respective totals had increased to well over 42,000 and 2500 acres. The area of land directly provided under Defence of the Realm Regulation 2L was 284 acres, the remainder being provided by the public-spirited action of proprietors and local authorities.

So long as hostilities lasted, emergency legislation, such as Defence of the Realm Regulation 2L provided sufficient machinery wherewith to meet what was doubtless then regarded as a temporary demand of an extraordinary nature; but it soon became apparent that only a small proportion of the people who had cultivated allotments during the war would be content to give up their plots of land on the return of peace. A demand arose for permanent machinery and simplification of the procedure whereby allotments might be provided by Local Authorities. This was met to an appreciable extent by the incorporation in the Land Settlement (Scotland) Act, 1919, of provisions which transferred the powers of County Councils under the Act of 1892 to Parish Councils, and did away with Provisional Order procedure by giving the Board of Agriculture power, subject to the approval of the Secretary for Scotland, to authorise the compulsory acquisition of land by Town or Parish Councils. For the first time too, a special allocation of public funds was made, the Board being authorised to apply monies out of the Agriculture (Scotland) Fund to an amount not exceeding £4000 in any one year for the purpose of encouraging and developing the provision of allotments throughout Scotland in such manner as they might think fit. It is also important to note that provision was made for compensating statutory allotment holders for disturbance under the Agriculture Act, 1920.

Despite such new legislation, however, there continued to be urged on the Government the inadequacy of the steps so far taken to meet the demand for security of tenure and reasonable compensation for disturbance for allotment holders in general. The force of these representations was recognised by the appointment in August 1921, by the Minister of Agriculture and Fisheries and the Secretary for Scotland, of a Departmental Committee to investigate the position as regards the provision of allotments by

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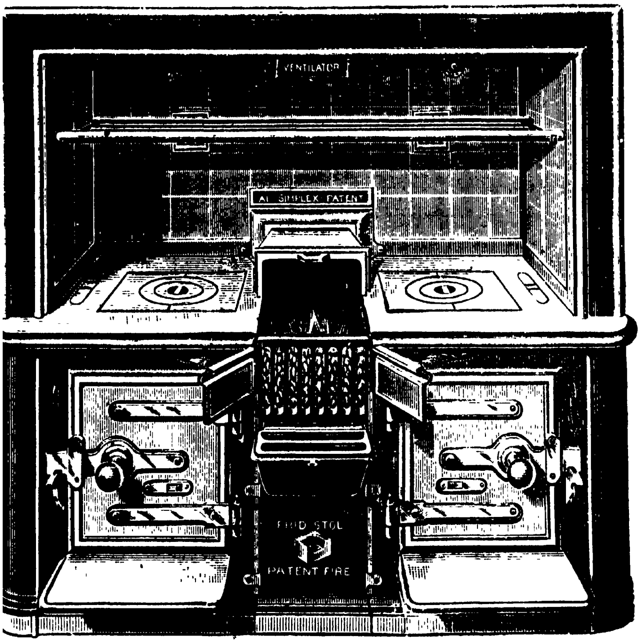

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local authorities in Great Britain. The Committee's report[1] was issued in January last, and following on the recommendations made therein two new Allotments Acts have now received the Royal assent—one applicable to England, and the other, the Allotments (Scotland) Act, 1922, to Scotland.

The new Scottish Act requires to be read with the Acts mentioned above, viz., the Allotments (Scotland) Act, 1892, the relative sections of Part IV. of the Local Government (Scotland) Act, 1894, and Part III. of the Land Settlement (Scotland) Act, 1919. Each of these Acts is now amended considerably. These Acts, as amended, with the new Act, are to be known as the Allotments (Scotland) Acts, 1892 to 1922. A system of legislation by reference has therefore been retained, but considerable progress towards codification has been made.

The new Act applies to "allotments" and "allotment gardens," between which a distinction is drawn as to size. An "allotment garden" is defined as meaning "an area not exceeding 40 poles, which is wholly or mainly cultivated by the occupier for the production of vegetable crops for consumption by himself or his family, and is not let to the occupier during his continuance in any office, appointment or employment held under the landlord or let along with any dwelling-house." In the Allotments Acts as a whole, except certain particular provisions, the expression "allotment" is to include an "allotment garden" so defined.

Town Councils and Parish Councils are retained as the local authorities under the Allotments Acts. It is open to them (under a section which supersedes the corresponding section of the 1919 Act), where they are unable to obtain land by agreement at a reasonable price or rent or on reasonable conditions, to apply to the Board of Agriculture for an Order authorising compulsory purchase or leasing as the case may be. Restrictions are imposed where the land desired has been acquired for certain public undertakings, and the Local Authority is now required to proceed under the Board's Order within three months of its issue, otherwise it becomes null and void (Section 13).

Section 19 of the 1919 Act which gave the Secretary for Scotland discretion to require the appointment of Allotments Consultative Committees in Burghs is repealed, and in lieu thereof Section 9 of the new Act makes the appointment of Committees obligatory in all burghs of a population of 10,000 or upwards, unless exemption is granted by the Board of Agriculture. The functions and composition of such Committees are defined.

The obligations of a Town Council under the Allotments Acts are, where the population of the burgh is 10,000 or upwards, limited to the provision of allotment gardens not exceeding 20 poles in extent. Town Councils and Parish Councils are given important new powers of entry on unoccupied land (Section 10), which is defined as meaning "land in respect of which no person is entered as tenant or occupier in the valuation roll in force at the date of the notice of intended entry, and which has not been let and occupied subsequent to the making up of the valuation roll and before the date of the notice." Somewhat similar powers were conferred temporarily on Town Councils under Defence of the Realm Regulation 2L.

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[1] *Report of the Departmental Committee on Allotments*, obtainable from H.M. Stationery Office. Price 6d. net.

The Board of Agriculture are empowered to let for use as allotments land which has been acquired by them for small holdings.

The general provisions regulating the leasing of land by Local Authorities are set out in detail in Section 6 of the Act. A number of these come in place of Section 26 of the Act of 1894, which is now repealed. Subsection 1 (*a*) states that where land is leased a "Local Authority may let to one person an allotment or allotments (not being an allotment garden or allotment gardens) exceeding 1 acre but, if the land is taken on lease compulsorily, either not exceeding in the whole 4 acres of pasture, or 1 acre of arable and 3 acres of pasture, or not exceeding 4 pounds in annual value."

In the case of "allotment gardens," of which the definition has already been quoted, one person may hold two or more if the aggregate extent does not exceed 40 poles, but otherwise one person is not to hold more than one allotment garden provided by a Local Authority, and subletting is prohibited (Section 5). Where a lease of land is effected compulsorily, it is to be for a period of not less than ten nor more than thirty-five years.

Section 7 permits of the acquisition of land by a Local Authority by purchase or leasing for the provision of common pasture.

The foregoing provisions are all of very direct interest to allotment holders, existing or prospective, but the sections which perhaps affect most immediately the occupiers of the plots now so common in all our cities and towns are the first two sections of the Act. These deal with the question of the termination of tenancies of allotment gardens, and of recovery of compensation in the event of the plotholder being required to remove. It may be remarked, as of interest, before proceeding further, that in these sections, as also in other parts of the Act already referred to, recognition is extended for the first time to the considerable number of associations of allotment holders that have come into being throughout the country, and whose activities have been instrumental in giving the movement the prominence which it deserves. Such associations are classified with local authorities in the opening sections of the Act. Section 1 provides that where land is let by a local authority, an association, or any other person, for use by the tenant as an allotment garden, the tenancy shall not be terminable except subject to certain conditions. To appreciate the scope of these conditions Section 2 must at the same time be read. Either six months or longer notice must be given, the notice to expire between the first day of November and the first day of May, or three months' notice where the land is required for industrial purposes. Corporations or companies are permitted to resume possession for the purpose of public undertakings only under a power of resumption contained in the lease of the land. Otherwise, arrangements are governed by certain provisions in Section 2 as to compensation. Thus a tenant is entitled to compensation if his tenancy is terminated between May and November, or if resumption of possession is completed at any time under the remaining provisions of the first section. Compensation is limited to compensation for growing crops and for manure applied to the land, the amount to be based on the value of such crops and manure to the incoming tenant. Provision is made for determination of the amount of compensation by arbitration in default of agreement. These sections apply, with limitations, to current tenancies and, while it is to be noted that a tenant may himself give good cause for resumption by irritancy of the lease or by breach of the Local Authority's regulations, it will be admitted that very adequate safeguards have been provided against capricious resumption, and that in the general case a plotholder is relieved of the fear of ejection before he has gathered his crop from the ground.

The remaining sections deal with matters incidental to the main provisions of the Act, and are of minor importance. Attention might, however, be directed, in conclusion, to Section 17, which deals with the subject of rating of allotments. Local authorities or associations may be deemed the occupiers of land for the purpose of any assessment, so providing that the local rates may be apportioned according to the rent of the land as entered in the valuation roll. It is also declared that in Section 347 of the Burgh Police (Scotland) Act, 1892 (which relates to the valuation of arable lands, etc.), the expression "ground used for nurseries, market gardens, or for agricultural purposes" is to be held as including ground used for allotments.

THE FALL IN FARM WAGES.

SIR JAMES WILSON, K.C.S.I.

IN 1907 the Board of Trade made an enquiry into the earnings and hours of labour in agriculture, and, according to the Report then published, the average weekly earnings of able-bodied horsemen for all Scotland were 19s. 8d. (cash 14s. 4d., allowances 5s. 4d.). Throughout Scotland a difference is made between the systems of remunerating married men and single men employed on farms, the married man receiving a house and certain allowances in kind, while the single men generally either live with their relatives or are boarded and lodged by the farmer, though in some parts of the country they live in bothies and are given allowances in kind, considerably smaller than those made to the married men. The married ploughmen are the most important class of farm-workers, and in the following remarks I confine attention mainly to them. The statistics given for 1907 are for all adult horsemen, excluding grieves and foremen. Between 1907 and 1914 there was a rise in cash wages, probably averaging about 2s. a week, and it may be roughly estimated that in the summer of 1914 the average earnings of the married ploughman in Scotland were about 22s. a week.

In the winter of 1919–20 the Board of Agriculture issued schedules to a number of selected farmers in the different counties and obtained returns covering about 4 per cent. of the total number of farm-workers. On the basis of these returns I drew up a report which was published by the Board of Agriculture. According to these returns, the average earnings per week of an ordinary married ploughman in the winter of 1919–20 were about 50s. (cash 39s., allowances 11s.). When that report was written, new bargains had been made in the greater part of the country, with effect from Whitsunday 1920, and on the information then available I estimated that in summer of 1920 the average earnings of an ordinary married ploughman were for all Scotland about 55s. a week (cash 42s., allowances 13s.). Since then the method of issuing schedules to farmers has not been repeated, and the only information now available as regards the wages paid to farm-workers is to be got from the reports furnished to the Board of Agriculture by their crop reporters in the different counties, from the summary published in the *Scottish Farm Servant*, and from the reports in the public press on the results of the hiring fairs. This information is obviously much less full and less trustworthy than that given by schedules furnished by a large number of individual farmers, who know exactly what cash wages and allowances they pay to their different workers; but it is, perhaps, sufficient to enable a rough estimate to be made as to the changes which have taken place.

Married Ploughmen.—The great majority of the married men in Scotland are engaged either for a whole year or half a year, the period of engagement running from either Whitsunday (28th May) or Martinmas (28th November). In some parts of the country the yearly engagement runs from Whitsunday and in others from Martinmas. The rate of wages agreed upon depends mainly on (1) the level of prices when the bargain is made; and (2) the relation between the demand for labour and the supply of labour at the time. As regards prices, valuable statistical information can be got from the *Labour Gazette's* estimate of the cost of living of a working-man's family in Great Britain, although it must be remembered that this figure requires considerable adjustment before it can be applied to the case of the married ploughman in

Scotland. According to those estimates, the index-figures for the cost of living (July 1914 being taken as 100) were as follows:—

COST OF LIVING.

Beginning of Month.	Index-Figure.
July 1914	100
June 1919	205
Decr. 1919	225
June 1920	250
Decr. 1920	269
June 1921	219
Decr. 1921	199
June 1922	180

It will be seen that on the 1st June 1919 the cost of living was about double what it had been immediately before the war. It rose to two and two-third times the pre-war cost on 1st December 1920; fell rapidly during the following twelve months, until on 1st December 1921 it was again about double the pre-war cost; and has since fallen further, until for 1st June 1922 the cost of living was estimated as about 80 per cent. above that of July 1914.

The character and quantity of the allowances in kind made to married ploughmen vary considerably from county to county, and almost from farm to farm, and even between individual workers on the same farm; but as there is in most counties a traditional rate of allowances which is more or less closely followed in making individual bargains, it is possible to strike an approximate general rate for each county.

In calculating the cash value of these allowances in the report of 1920, the values placed upon them by the different District Wages Committees for the purpose of the minimum wage were adopted. In making my present estimate, no such detailed information is available, and I have, as a basis for the calculation, adopted the following prices as approximately those prevailing in June 1922:— Value of house and garden, free of rent and rates, £5 per annum; potatoes, £3, 10s. per ton; milk, 1s. per gallon; oatmeal, 2s. 8d. per stone; coal, £2 per ton. Wholesale prices vary very much from one time to another and from one part of the country to another; so that it will be realised that the cash value placed upon the allowances is only roughly approximate.

Broadly speaking, the level of the wages of farm-workers is highest in the industrial area which stretches across the centre of Scotland from Dundee to Ayr; lower in the agricultural counties to the south and to the north of that industrial area; and lowest of all in the northern counties and especially in the West Highlands, where the pressure of population on the soil and the absence of competing industries makes the farm-worker willing to accept a comparatively low rate of wages rather than leave the neighbourhood of his home. It will be convenient therefore to treat those areas separately.

The Lower Clyde Valley.—In the Lower Clyde Valley, in the neighbourhood of Glasgow, comprising parts of the counties of Lanark, Dumbarton and Renfrew, and in North Ayrshire the married ploughmen are engaged for a term of six months and the proportion of their wages paid in allowances is comparatively small. In summer 1914 their average weekly earnings seem to have been about 24s. (cash 20s., allowances 4s.). By summer 1920 they had risen to about 61s. (cash 55s., allowances 6s.). In summer 1921 they were at their maximum—about 63s. (cash 58s., allowances 5s.). Last Martinmas, owing to the great fall in the cost of living and to the prevalence of unemployment, the average cash wage fell by about 9s., and for similar reasons there has been a further fall at Whitsunday of about the same amount; so that the present average earnings of an ordinary married ploughman in this area are about 44s. (cash 40s., allowances 4s.) a fall of 19s. a week in the last twelve months.

The Eastern Industrial Area.—In the eastern part of the central industrial area, which comprises Fife, South Forfar and the lowland part of Perthshire, the married ploughmen are generally engaged for the year from Martinmas, and most of them have, besides their cash wages, large allowances in oatmeal, milk and potatoes. In 1914 the average wage of a married ploughman in this area seems to have been about 24s. (cash 18s., allowances 6s.). During the period of rising prices, the cash wages rapidly rose and at the same time the value of the allowances increased until in summer 1921 the average earnings were about 60s. a week (cash 46s., allowances 14s.). Last November there was a reduction in the average cash wage of about 12s., and the further fall in prices reduced the cash value of the allowances; so that the present average earnings of a married ploughman in this area may be estimated at about 45s. (cash 34s., allowances 11s.) or much the same total as in the Lower Clyde Valley. As in this area the engagements made last November were for a whole year, the married ploughmen here have escaped the further reduction in cash wages whick took place at Whitsunday in the Glasgow area.

The South-Eastern Counties.—In the south-eastern agricultural counties, comprising Linlithgow, Mid-Lothian, East Lothian, Berwick, Roxburgh, Selkirk and Dumfries, the married ploughmen are engaged at Whitsunday for a whole year, and their allowances, consisting chiefly of a house and potatoes, form a small proportion of their total earnings. In 1914 their average earnings appear to have been about 22s. a week (cash 19s., allowances 3s.), being a little higher in Linlithgow and Mid-Lothian, and lower in East Lothian and Dumfries than in the other three counties, Berwick, Roxburgh and Selkirk. In summer 1921 the average was about 52s. a week, varying from 50s. in East Lothian to 53s. in Mid-Lothian and Linlithgow. At last Whitsunday, owing no doubt to the great fall in prices and to the prevalence of unemployment, there was a large reduction in the cash wage, amounting on the average to about 13s. as compared with last summer, and, as the value of the allowances has also fallen, the present average earnings of a married ploughman in these seven counties appear to be about 37s. (cash 32s., allowances 5s.), but vary from 36s. (cash 33s., allowances 3s.) in East Lothian to 40s. (cash 37s., allowances 3s.) in Linlithgow. There is thus a fall in the average earnings in these counties of about 15s. as compared with last summer.

There is little information available regarding present wages in Kirkcudbright and Wigtown. In Peebles the present earnings seem to average about 40s. (cash 36s., allowances 4s.) and in Upper Lanarkshire about 43s. (cash 38s., allowances 5s.), a fall in each case of about 15s. as compared with last summer.

The North-Eastern Counties.—From the northern part of Forfarshire northwards along the east coast as far as Ross-shire, the married ploughmen are mostly engaged for a whole year from Whitsunday and are given large allowances in kind. There is a tendency to a decrease in earnings as one goes north, but Aberdeenshire may be taken as typical of these north-eastern counties. In 1914 in Aberdeenshire the average earnings of the married ploughmen seem to have been about 21s. (cash 13s., allowances 8s.). By summer 1920 they had risen to 51s. (cash 33s., allowances 18s.). There was comparatively little change in the cash wage at Whitsunday 1921, but there has been a large fall at this last Whitsunday in the average cash wage and, as the value of allowances has also fallen greatly, owing to the fall in prices, the present average earnings of a married ploughman in Aberdeenshire may be estimated at 37s. (cash 26s., allowances 11s.), a fall of 14s. a week compared with summer 1920.

Little information is available regarding the Northern Counties or the West Highlands, but there also it appears there has been a fall in the average earnings since summer 1920 of about 11s. a week, the present earnings in Sutherland being about 34s. (cash 20s., allowance 14s.), in Orkney 30s. (cash 16s., allowance 14s.), and in Shetland 35s.

Summary.—I append a statement (on the following page) giving estimates, based upon the available information, as to the present average earnings of married ploughmen, county by county. This estimate may be compared with the similar estimate given for summer 1920 on page 49 of my printed report.

These estimates are, as already explained, only roughly approximate. Taking them as they stand, they give an arithmetical average (for the twenty-seven counties mentioned) of 40s. 1d. (cash 32s. 10d., allowances 7s. 3d.), which may be compared with the corresponding average for summer 1920 of 53s. 9d. (cash 41s. 5d., allowances 12s. 4d.), which would indicate an average reduction during the past two years of 13s. 8d. (cash 8s. 7d., allowances 5s. 1d.). It is necessary, however, to allow for the fact that there are more ploughmen in the counties where the earnings are high than where they are low, and also for what seems to be the case, namely, that the ploughmen, who at last Martinmas and

Whitsunday stayed on in their former employment and made their new bargains with their employers at home, secured better terms than were got at the hiring fairs by those men who changed their employment and had to make their new bargains under the stress of competition. I am inclined, therefore, to estimate that for all Scotland the present average weekly earnings of married ploughmen, excluding grieves and foremen, are about 42s., as compared with 55s. in summer 1920, and with 22s. in summer

AVERAGE WEEKLY EARNINGS OF MARRIED PLOUGHMEN IN SUMMER 1922.

County,	Cash	Allowances	Total.
	Shillings.	Shillings.	Shillings.
Dumfries	32	5	37
Selkirk	32	5	37
Roxburgh	32	5	37
Berwick	32	5	37
Peebles	36	4	40
East Lothian	33	3	36
Mid-Lothian	36	3	39
Linlithgow	37	3	40
Stirling	47	3	50
Dumbarton	40	4	44
Lanark (South-East)	38	5	43
„ (Lower)	40	4	44
Renfrew	40	4	44
Ayr (North)	40	4	44
Argyll (Kintyre)	...	...	42 [1]
Fife (West)	48	3	51
„ (East)	34	11	45
Perth	34	11	45
Forfar (South)	34	11	45
„ (North)	29	11	40
Kincardine	28	11	39
Aberdeen	26	11	37
Banff	26	10	36
Moray	26	10	36
Nairn	26	10	36
Inverness (East)	26	11	37
Sutherland (East)	20	14	34
Orkney	16	14	30
Shetland	...	...	35 [1]
Average for all Scotland	32s. 10d.	7s. 3d.	40s. 1d.

[1] Omitted from average.

Note.—The comparatively high earnings in Stirling and West Fife are probably due to the fact that in those areas a considerable number of married ploughmen are engaged for a year from Martinmas at high cash wages, with small allowances. They have thus escaped, on the one hand, the reduction of wages which last Whitsunday affected their fellows in the Glasgow area, who are engaged for only six months at a time, and, on the other hand, the reduction in the value of allowances which has affected their fellows in East Fife and further north, a large proportion of whose remuneration consists of allowances, the cash value of which has greatly fallen.

1914, a fall of 13s. a week in the last two years, but still nearly double the level of summer 1914; and as, according to the *Labour Gazette's* statistics, the cost of living is now (August) 81 per cent. above what it was in July 1914, it would appear that on the whole the married ploughmen in Scotland are in a position to maintain their families at a standard of comfort at least equal to that which they had attained immediately before the war. Although there are indications that some farmers have reduced the number of their working staff, it seems that this reduction has been made chiefly at the expense of the single men, and that few married farm-workers have been thrown out of employment.

Single Ploughmen.—From the reports available, it appears that at last Whitsunday the single ploughmen, who in the greater part of the country are engaged for only six months at a time, have been driven by competition to submit to a larger reduction in their earnings than have the married ploughmen, and that a larger proportion of them have lost their employment on farms. But probably they have in this respect suffered less than have those engaged in other industries.

Women Workers.—The practice of employing women to work in the fields is most prevalent in the south-eastern counties—Mid-Lothian, East Lothian, Berwick and Roxburgh—where they are generally engaged for a year from Whitsunday at a cash wage fixed at so much per week, plus a harvest fee of from £1 to £2, and sometimes a small allowance of potatoes. These additions may be reckoned as worth about 1s. per week all the year round. In 1914 their average earnings seem to have been about 13s. a week. In summer 1920 they had risen to an average of about 30s. Little change was made at Whitsunday 1921, but at this last Whitsunday there was a general fall of about 8s., and the average earnings of the women outworkers in these four counties may be estimated as at present about 22s. per week (cash 21s., allowances 1s.).

In the other counties women working on farms are generally employed as dairymaids or kitchenmaids, and are boarded and lodged in the farm-house. There seems to have been an insufficient supply in some areas, and the reduction in the wages of these women last Whitsunday has been less in proportion than in the case of the men. Apparently, in most areas in the centre and south of Scotland, an experienced kitchenmaid had little difficulty in securing a place at a cash wage of £20 for the half-year, though inexperienced girls had to be content with less, and experienced dairymaids got in some areas up to £25 for the half-year.

Working Hours on Farms.—In 1919 and 1920, largely in consequence of a joint recommendation made at a conference, held at Perth on 14th February 1919, between representatives of the National Farmers' Union and the Scottish Farm Servants' Union, a considerable reduction in farm working hours took place in a great part of the country, especially by the adoption of the nine-hour day in summer and the Saturday half-holiday, except in busy seasons. Among other things, it was agreed that the working hours should be reckoned from the time the horses leave the stable to the time at which they return to the stable. During the last year there has been a movement among the farmers in several counties for an increase of the working hours. There seems to have been little desire to curtail the Saturday half-holiday at slack times where that had been granted; but in several counties the farmers expressed a wish to have the working hours reckoned from stable to land's end—that is, from the time the horses leave the stable to the time work stops in the field. This would mean on the average an addition of fifteen or twenty minutes a day to the time actually spent on work in the field. A desire was also expressed in some areas, where the rule had not already been adopted, that during harvest the working hours should be ten per day for six days a week. The Farm Servants' Union opposed these increases in the working hours, but apparently at last Whitsunday many farmers were able to make bargains in accordance with their wishes in this respect, and probably in great part of the Lowlands it is now the rule that working hours shall be reckoned from stable to land's end, and that the ploughman shall be bound to work for ten hours a day for six days a week during harvest, for nine hours a day in summer, and from dawn to dusk in winter—a half-holiday being conceded on Saturday afternoons, except at busy seasons. There are, however, many exceptions.

The Scandinavian Fodder Unit.

MR D. W. STEUART, B.Sc., supplies the following explanation of the fodder unit used in the Scandinavian countries and the Swedish estimate of the proteid requirements of dairy cows.

One of the principal objects of milk testing is to be able to examine the relation between the fodder supplied to cows and their yield of produce. In this regard it is useful to be able to compare (*a*) individual cows; (*b*) individual herds; (*c*) breeds and so on. To be able to do so satisfactorily we require to know in what proportions various feeds can replace one another in the feeding of cows.

In the Scandinavian countries the milk-tester has to weigh and test the milk, weigh the rations, and so organise his work that at the end of the year he can assess the performance of individual cows. Thus some twenty times per year, at equal intervals, a day's rations for the cows have to be weighed. To assist in this matter, and facilitate the feeding of the cows according to the amount of milk they are yielding, the cows may be divided into four groups—high, medium and low yielding and dry cows. In large herds groups may be sub-divided. By this arrangement the tester need only weigh the food of each group. When he arrives at a farm the fodder weighing is commenced first, as he wishes to weigh as nearly as possible the fodder which actually produces the milk which he is going to weigh later. So, when possible, fodder weighing commences half a day sooner than the milk testing.

Concentrates may be weighed for each group but never simply for the herd as a whole. For bulkier foods several barrow loads can be weighed and, the weight of the barrow being allowed for, an average is struck for the weight of a barrow load. Sheaves of straw can be fed in the same way, *i.e.*, after finding the average weight per bunch. Any straw left over or scattered is judged by eye and allowed for. The following figures represent fodder weighing per cow for each group in kilograms (1 kilo. = 2·2 lb.).

Group.	Mixed Concentrates.	Mangels.	Sugar Beet Offal.	Hay.	Straw.
I. . . .	1·2	15	—	2	6
II. . .	2·4	10	10	2	6
III. . .	3·6	13	13	3	5
IV. . .	4·5	15	15	4	4

When the same mixture of cakes and meals is supplied to each group the weight of the mixture may be entered in the records as above, but a note must be made of the composition of the mixture. (This could not be done in the case of proprietory mixtures unless the manufacturers were forced to declare the ingredients and their proportion in the mixture.)

We require now to know the proportion in which various foods can replace one another in a cow's ration without the weights of the cow or of its produce being affected thereby.

This problem was tackled by N. J. Fjord (1887–91) and continued by others, so that when the first milk-testing society was started the following unit values were adopted by which to gauge the fodder supplied—

1 pund mixed concentrates;
= 2·5 pd. hay;
= 4 pd. straw;
= 10 pd. greenfodder, swedes, mangels, carrots;
= 12·5 pd. turnips;
= $\frac{1}{6}$th pasture day.

The first "milk-testing society" was the Vegen "Control Union" formed 23rd January 1895, by S. P. Knudsen, farmer, pr. Vegen, Denmark.

The milk-testing movement soon spread and when the first society was formed in Scotland in 1903 there were 362 in Denmark, 188 in Sweden, 137 in Norway, and others in Tyskland and Finland.

In 1913 Professor Nils Hansson of Stockholm published his paper on "A New Method for Calculating the Production Values of Foods for Cows," in which he showed that the unit values then being used by the Scandinavian farmers had a scientifically sound basis and he further brought them into line with the feeding experiments of Kellner (1892–1911). The Danish unit of comparison had been 1 pund (= ·5 kg. = 1·1 lb.) of mixed concentrates, commonly consisting of $\frac{1}{2}$ oats $\frac{1}{2}$ barley, while in other places the unit was 1 kilogram of barley or mixed corn. In October 1915 representatives of the Danish, Swedish and Norwegian control unions met in conclave at Copenhagen and decided to adopt a common unit, viz., 1 kg. barley, in all their work. And thus the common Scandinavian fodder unit came into being. As we do not use kilograms in this country we adopt 1 lb. of barley as our unit In July 1921 at the Northern Agricultural Investigators Congress at Copenhagen, Professor Hansson described the practical technique of feeding experiments by which the unit values of feeds could be ascertained in the feeding of cows, pigs or horses.

If we now compare a Danish feeding standard for cows (Rasmussen's Fodringslaere, 1920) with the Swedish, we find a common unit being used in not quite identical feeding standards. Nor are the unit values fixed absolutely. There is some variation to allow for differences in food value specially in the case of the bulkier foods. Thus the unit values of roots depend on the percentage of dry matter in the roots, and the unit values of hays depend on the district (Norway, 2·2—2·3, Sweden, 2·5) and on the weather at harvesting. If a large district has a bad hay harvest the authorities in charge issue general instructions to the assistants with regard to the modified unit values to be used by them when they transfer weights of hay into fodder units on the official record sheets.

The milk-testing assistants are advised to use the average or normal unit values in all cases unless sure proof of inferior food value can be obtained. The assistants appear to act in an advisory capacity with regard to the feeding on the farms.

With what completeness the fodder record sheets are filled in is indicated by the following summary of the feeding in the first Swedish control union during its first and its eleventh year.

HVILAN'S CONTROL UNION. % OF TOTAL UNITS IN FOODS SUPPLIED.

Year.	Oil-cakes.	Grain.	Bran.	Roots.	Beet Offal.	Pasture and Green-fodder.	Hay.	Straw.
1898–99 .	5·6	4·0	16·9	·1	12·8	29·8	17·1	13·7
1908–09 .	18·3	1·1	14·5	13·1	11·2	20·1	10·0	11·7
Increase .	12·7	...	...	13·0	...	...	...	...
Decrease .	...	2·9	2·4	...	1·6	9·7	7·1	2·0

The unit method of feeding was described in this *Journal* some time ago (October 1920) and has been adopted in Professor Wilson's "Breeding and Feeding of Farm Stock," 1921.

PROTEID REQUIREMENTS OF COWS.—Briefly, the Swedish feeding standard for cows is:—

Dry cows . . . . 1 unit per 100 lb. live-weight.
Cows in milk . . . . 1 „ 150 „ „
„ . . . . 1 „ 3 „ of milk.

Dry cows in lean condition and heifers with their first calf get something extra. It is, however, with the proteid requirements of cows that we have to deal at present.

Pre-War Standard.—Before the war the Swedish standard was as follows:—

	Digestible proteid per head per day.
Per 1000 lb. live-weight . . .	·65 lb.
Per 10 lb. milk	·45 „

War-Time Standard.—During the war cattle cakes were scarce and dear, and home produced food had to be used to a greater extent. So a modified war-time standard came into use:—

Per 1000 lb. live-weight . . .	·50 lb.
Per 10 lb. milk	·40 „

Post-War Standard.—This led to an interesting series of experiments as the result of which the post-war standard has become:—

Per 1000 lb. live-weight . . .	·50 lb.
Per 10 lb. milk	·45 „

Professor Hansson's report (1920) on these experiments may be thus summarised:—

1. The pre-war standard is entirely sufficient for the requirements of the cows.
2. The war-time standard is adequate only for high yielders with a low fat percentage.
3. That ·5 lb. digestible proteid per 1000 lb. live-weight fully covers the maintenance requirements of cows for some months after calving and the first part of the in-calf period. During the last part of the in-calf period their needs increase by ·10 – ·12 lb.
4. As the fat (and proteid) content of milk increases so the proteid in the food must increase—somewhat as follows:—

Per 10 lb., 3 per cent. milk .	·40 lb. digestible proteid.	
„ 4 „ „ .	·44 „	„
„ 5 „ „ .	·48 „	„

5. The daily fodder units and the digestible proteid necessary per day and per unit of the total ration for cows of 1100 lb. live-weight and yielding milk with 3·5 to 4 per cent. fat would be:—

	Fodder Units.	Digestible Proteid.			
		Lb.	Lb. per Unit.		
				War.	Pre-War.
Bare maintenance .	7·3	·55	·075	·075	·098
11 lb. milk . .	11·0	1·05	·095	·090	·110
22 „ . .	14·5	1·54	·106	·098	·116
33 „ . .	18·3	2·03	·111	·102	·120
44 „ . .	22·0	2·53	·115	·105	·122
55 „ . .	25·7	3·03	·117	·107	·124

6. The proteids of hay can to a great extent replace the proteids of oilcake; but the long fodder supplied must not over-tax the animals capacity for dealing with such. High yielders must still have some of their proteid supplied as concentrates.
7. When oil-cake proteid is replaced by hay proteid there is a tendency for the milk yield to go down and the fat per cent. to rise, the actual production of butter fat being little affected.
8. If we estimate the proteid in hay by the usual method, then it is fully as useful as an equal weight of the proteid of ordinary oil cake, *e.g.*, groundnut cake.
9. No flavour developed in the milk from the feeding of as much as 21 lb. of lucern or greenfodder hay.

The following are specimen rations from the experiments :—

I. On which cows of 1080 lb. gave 25 lb. of milk with 3·7 per cent. fat.

Half oats, half barley, ground . . .	3·7 lb.
Swedes	44·0 „
Turnips	44·0 „
Lucern hay	15·4 „
Greenfodder hay (56% leguminosae) .	5·5 „

II. On which 1000 lb. cows gave 22 lb. milk with 3·6 per cent. fat.

Half oats, half bran	3·3 lb.
Turnips	22·0 „
Grass and clover hay (43% leguminosae) .	8·8 „
Greenfodder hay (20% leguminosae) .	11·0 „
Barley straw	3·3 „
Rye straw	2·7 „

III. On which 1260 lb. cows gave 33 lb. milk with 3·1 per cent. fat.

Cotton cake	2·9 lb.
Rape cake	1·3 „
Bran	2·2 „
Oats	·5 „
Mangels	88·0 „
Grass and clover hay (20% leguminosae) .	9·9 „
Lucern hay	8·8 „

THE following note on a disease of barley ears has been contributed by Dr W. G. Smith of the Edinburgh and East of Scotland College of Agriculture :—

A Disease of Barley Ears.

This season a number of cases have come under notice of barley with defective ears. The disease is reported as common about Forfarshire and specimens have also come from Berwickshire and Roxburgh. The leaves of affected plants wither prematurely, and although the ears are formed, the grains are lean, do not fill up, and are frequently discoloured especially at the lower end. This brown discoloration of the lower half of barley grains is commonly attributed to "heating," but this year it was seen in the ear in July when the healthy crop was still green. The drooping and withering of the leaves is a feature of the disease, so that in July only the upper one or two leaves showed green, and sometimes all the leaves were withered. Leaf-stripe, a common disease in barley, was also observed, but this differs from the disease now described, in that no ears appear, or they are caught in the upper sheath and do not emerge to stand erect, and the brown discoloration forms distinct stripes on the leaves and sheaths.

Examination of the discoloured leaves showed numerous yellow or brownish blotches, small in size except where adjoining ones had fused together. On these blotches, spores of at least two fungi were observed, viz., rust and leaf-spot. The uredospores of the rust (*Puccinia glumarum*) occurred on yellow blotches, in small groups forming broken lines on the leaves and straw; winter spores also have been observed. The other fungus causes browner discolorations, some of which bore the spores of a well-known leaf-spot of barley (*Pleospora or Helminthosporium teres*). This disease is closely allied to the *Helminthosporium* (*Pleospora*) which produces leaf-stripe of barley, and it has the same elongated dark brown spores, each divided by three or more cross walls. When the discoloured leaves were placed under culture conditions, several other fungi appeared, but these are regarded as moulds growing on the dead leaves.

The defective development of the ears is to be traced to malnutrition due to the operation of rust and leaf-spot fungus, which this season have been unusually vigorous. Rust of barley is not often observed in Scotland, but this season seems to have encouraged it. So far as is known barley rust is not transferred to or from wheat and oats. It is noteworthy that wheat rust has been more prevalent in Scotland this year than usual; it was seen about Perth at the end of June, on many fields, covering all the leaves and beginning on the unfolding ears. A season so favourable to rust on wheat has probably encouraged the spread of rust on barley. The other fungus—the leaf-spot—is common on barley, but as a rule it is limited to the lower leaves and does little damage to ears. Danish observers report, however, that it may affect the ears in the same way as described above. It is said to do more damage to the long-eared Chevalier barleys than to the broad-eared varieties. Early sowing in a cold soil encourages the growth from spores conveyed on the seed. Later extension from the primary attack is favoured by a cool moist summer, especially in damp hollows.

Both rust and leaf-spot begin from spores carried on the seed; they attack the seedlings, but their further extension depends mainly on the season. The protracted and moist harvest of 1921 was probably responsible for a considerable infection of the seed.

The grain from diseased ears of the present year will lead to infection of the seed for next year.

Preventive Measures.—As already stated, the diseased ears carry lean, more or less stained grains, so that in selecting seed preference should be given to plump clean grains. The light diseased corns can be cleaned out to some extent by vigorous dressing, but there is always a risk that the heavier corn from affected crops will carry the fungus spores to next year's crop. Good results may be expected from steeping the barley seed-grain in formaline, which in recent years has been found superior to the older sulphate of copper steep. Barley is more liable to be injured in germination, and the strength of steeping solution should be only half that used for wheat or oats. One ounce (or one tablespoonful) of formaline in 1 gallon of water is regarded as a safe strength. It has been tested for covered smut and for leaf-stripe, and it should be effective for the leaf-spot disease and to some extent for rust. The seed is spread out on a floor and watered with the formaline solution (about 1 gallon to a 4 bushel sack), all the grain being wetted by thorough stirring. The heap is left for twelve hours covered with sacks soaked in formaline, then spread out to dry for sowing.

Ensilage.

THE following notes on making silage have been supplied by Mr Ewan Fraser Campbell of Tarbert, Loch Fyne; his experience should be of interest and value to west country farmers especially :—

Though I have been growing forage crops for ensilage and soiling purposes for only two years, there is no doubt whatever in my mind that this system is greatly superior to the Norfolk rotation for the wet climate of the West Coast.

My ensilage is made from a mixture of winter vetches, Scotch rye and Hamilton oats in the proportions by weight of 56 lb., 56 lb. and 70 lb., a total of 182 lb. to the statute acre. This year I am experimenting in one field with field peas in the place of the vetch. Up to now I have sown the crop in early April, *i.e.*, at the same time that the oat crop is put in. The treatment of the land is the same as for the latter crop. The seed is broadcasted by hand, harrowed in and rolled. The crop is cut green about the time the grain heads, and I usually cut it with a high stubble, say 6 inches, with the ordinary hay mower. The stuff is allowed to wilt for a few hours, then is raked into winrows with an ordinary hay rake, and gathered to the stack with the hay collector. I build my stacks in the field where the crop is grown. I am not yet satisfied that the proportions of cereal and vetch in the seed mixture given above are the most suitable, but the mixture given has done quite well. The main point is not to sow too much vetch or the crop will lodge. Also I think a heavier-leaved oat, say the Dun variety, might give better results. The object is to get plants

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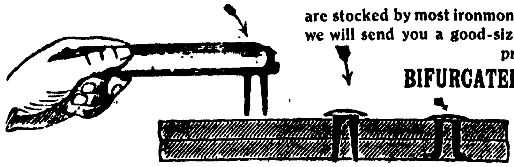

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that will grow at about the same rate, so that none are smothered. Also good tillering capacity is a desideratum.

When making the stack the great thing is to pack it evenly all round. Mine are built circular, 16 to 18 feet in diameter and 10 to 14 feet high at first. A stack of this size can be made from the produce of about two acres of the mixture mentioned. Heating, of course, starts at once. The temperature is taken the following morning in various parts of the stack with an ordinary rick-tester. It will reach 150 to 160 degrees F. in twenty-four to forty-eight hours. When it reaches this point more stuff is put on, or if no more is available 6 inches of earth are thrown on top. This should check the heating. If by next morning the temperature has risen again more earth is added, and so on until there is no rise in temperature. The stack is then finished off by adding earth to a total depth of 18 inches to 2 feet. The sides should be well plucked, not trimmed with a knife, to minimise waste. A coping of sods should be placed, grass down, around the verge of the stack to hold the loose earth in place. Before throwing up the earth the top of the stack should be covered with an inch or two of any waste material, *i.e.*, bracken. The stack should be built with straight sides, and finished off with a conical top, the centre 3 feet or so higher than the sides. The centre settles down as the stack subsides.

I have found it essential to let the heating get a good start, and have found it a good rule to allow the stacks to steam visibly before the first weight is applied. If the weight is put on too soon the stack consolidates too fast, and the moisture is squeezed out drops with consequent waste of nutritive value. A stack 12 to 14 feet high will eventually settle down to about 4 to 5 feet.

By cutting the standing crop with a 6 inch stubble, I find that I get a good second growth. Last year my first crop was over 4 feet high, it was cut and stacked within twelve weeks from the date of sowing, and by late September I had a second crop 18 inches to 2 feet high. Practically all the rye and some of the oats had headed again. I thus got one good crop and a medium crop from the one sowing in roughly six months. After the first cutting the 6 inch stubble got a light dressing of dung, 5 to 6 tons per acre.

When the stack is cut into it should be done in wedge-shaped sections, like cutting into a tart, using a hay knife. The earth covering is only removed as the cutting proceeds. It is best not to cut out more than three days' supply at a time. Some of my ensilage is fed in the byre, and some is spread out in the field like turnips. In both cases all is consumed, for the beasts are very fond of it once they acquire the taste. I have been able to decrease my turnip break about 75 per cent. since I started making ensilage, and I have had no trouble in keeping the cattle in condition.

I am fairly well convinced by my own experience, little as it is, that the possibilities of forage cropping are very great. For instance, the second crop referred to above was eaten off by lambs, and then what was left was ploughed in. A small corner was, through oversight, not turned over, and this spring the cereals started to come away again. It may, therefore, be possible in this climate where there is little or no frost to sow such a crop in the autumn, after the corn has been harvested, for cutting in June, and then sow a quick-growing crop for green soiling in the back end.

Demonstration Poultry Croft.

THE first report by Miss Mary Young on the Poultry Demonstration Croft at Littleton, Crieff, has recently been received from West of Scotland Agricultural College. The college have established Demonstration Poultry Crofts in districts in which poultry-keeping on crofts has not been receiving the attention it deserves. The method adopted is to select an enterprising crofter's wife who is willing to follow closely the guidance of the County Instructress, to keep careful account of all transactions, and to demonstrate to visitors from the surrounding district the methods she practices. There are other poultry demonstration crofts in operation at Glenluce, Wigtownshire, and in Tiree. The interest which the public take in these demonstrations is shown by the fact that at Glenluce there were over 1300 visitors last year. The demonstration is generally undertaken for five years, but the one in Tiree has been so valuable that it has been decided to carry it on for another five years.

The Littleton demonstration was established in 1920 by the purchase in April of day-old chicks of good strain, a brooder and a poultry-house and run; by September male birds and pullets unsuitable for keeping had been sold off for table or stock purposes, and after deducting the cost of food and the day-old chicks it was found that the actual cash expenditure on the pullets had been reduced to £2, 16s. To arrive at a figure for cost of labour and interest on capital the pullets were valued at market price, so that when the demonstration actually commenced there were thirty-three good White Leghorn pullets valued at £8, 15s. 5d., and house, run, brooder, etc., valued at £53, 4s. 6d.

The pullets were housed in a substantial, well-ventilated and well-lighted house, and were confined in a run which provided about 30 square yards per bird. To keep the run fresh it was closed up for a month or two in the early spring, when the birds could be permitted to run over the adjoining ground which is used for growing raspberries.

The house was kept scrupulously clean, and the floor always well covered with clean litter.

In feeding, the dry mash system was adopted. The chickens had been reared on wet mash and grain, but dry mash feeding was started when they were about five months old. The birds adapted themselves readily to this system of feeding; it is found that the lighter breeds seem to be more easily changed from one method of feeding to another than heavier breeds.

The feeding consisted of grain in the morning, 1 oz. being allowed per bird, dry mash during the day—the hopper being opened during the forenoon and closed in the evening—and 1 oz. of grain given as a last feed.

The grain in winter was composed of equal parts of oats, wheat and Indian corn or maize; and the dry mash of two parts bran, two parts thirds or sharps, two parts Indian meal, two parts crushed oats and one part fish meal.

During the summer months the quantity of Indian meal was reduced and no Indian corn was given.

The grain was always fed among the litter. Under this management the birds were kept in good condition, and the laying results were very satisfactory. There was also a great saving of labour.

A plentiful supply of fresh water and limestone grit was always before the fowls. Much more water is necessary when the food is given dry.

During the year seven birds died, mostly from ovarian troubles.

In September 1920 two male birds were purchased, and in the following spring a number of day-old chicks were bought and reared; it was decided, for the first year at least, to purchase day-old chicks rather than an incubator or broody hens. As more housing was required for the new birds, a cockerel house was

RESULTS FOR YEAR 1ST OCTOBER 1920 TO 30TH SEPTEMBER 1921.

Month.	No. Hens.	Eggs Laid.	Average Egg Yield.	Market Value of Total Eggs Less Sittings.	Cost of Feeding.	Eggs Sold for Hatching.		
						Dozens.	Value.	Market Value
Oct.	33	559	17·2	£10 16 4¼	£2 9 0			
Nov.	33	549	16·7	12 0 7	6 1 0			
Dec.	33	628	19	13 16 10	1 18 11			
Jan.	33	619	18·85	11 14 0¾	2 10 3			
Feb.	33	626	19	8 6 9½	1 10 4	4	£1 12 0	£0 10 8
Mar.	33	738	22	5 5 0	1 3 1	9	3 12 0	0 18 0
April	32	696	21·75	4 4 0	4 0 0	16	6 8 0	1 12 0
May	31	637	20·55	4 2 0		10	2 10 0	1 4 0
June	31	575	18·2	4 19 10	2 15 9	2	0 16 0	
July	31	545	18·16	5 9 5	2 1 6½			
Aug.	29	549	15·3	5 13 9½	2 1 6			
Sept.	26	259	9·6	3 11 11	1 6 7			
Totals		6980	216·3	£90 0 7	£27 18 0	41	£14 18 0	£4 4 8

Average No. of hens 31·6	31·6
Average No. of eggs produced per bird	216·3
Average cost of feeding per bird per week	4·0d.
Average cost of food to produce one dozen eggs	11·5d.
Average yearly profit per bird over feeding (1) all eggs at market rate	£2 2 0
Average yearly profit (2) including price of settings	£2 9 0
Average price obtained for eggs for commercial purposes	2¼d. per egg

secured, also a house and run for the pullets, which were placed on ground that had been cleared of gooseberry bushes. It is proposed to move the original house and run and to plant the ground with young fruit trees, thus utilising the manure produced by the birds. As the birds are used in this way for cleaning and manuring the ground for fruit no rent need be charged against them, and as no extra labour is employed for them the profit shown each year may be taken as interest on capital and wage return for the labour given by the crofter's wife.

The majority of the eggs were sold wholesale, but 41 dozen were disposed of for hatching purposes at a slightly higher rate. The following tables show the results obtained.

(The highest price obtained for eggs was in November and December, when the market rate was 5s. 4d. per dozen, and the lowest in March, April and May, when it was 2s. per dozen.)

During the year day-old chicks were bought and reared, and their cost is included in the trading account, which shows the actual position of the poultry demonstration finances at the end of the year.

TRADING ACCOUNT—OCTOBER 1921.

To valuation of houses, &c.	£53	4	6	By sales—(1) Cockerels .	£4	13	5
To valuation of pullets, .	8	15	5	(2) Eggs for table .	90	0	7
To stock bought (male birds and day-old chicks) . .	8	7	11	(3) Eggs for hatching	14	18	0
To houses, &c., bought .	27	13	3	By valuation—birds, as at 30/10/21	24	5	7
To foods bought—(meals, £12, 19s. 4½d.; grains, £21, 15s. 8d.; sundries, £1, 15s. 3d.	36	10	3½	By valuation—houses, &c. *Less* depreciation— (1) @ 10% £53, 4s. 6d. = £47, 18s. 1d. . (2) @ 5% £27, 13s. 3d. = £25, 18s. 1d. .	73	16	2
To balance (being profit) over actual expenditure and depreciation . . .	73	2	4½				
	£207	13	9		£207	13	9

BALANCE-SHEET.

LIABILITIES.				ASSETS.			
Capital	£98	1	9	Stock	£24	5	7
				Houses, &c. . . .	73	16	2
	£98	1	9		£98	1	9

It will be seen that part of the stocking and equipment is being purchased out of income, and that the full requirements for hatching are still to be obtained. On the lines adopted it was possible in 1920 to start this small poultry plant with a capital expenditure of rather less than £2 per bird.

Mrs Drummond who managed the experiment had no special experience, but is shown to have faithfully and creditably carried out instructions.

MESSRS A. CUNNINGHAM and W. T. H. WILLIAMSON of the Edinburgh and East of Scotland College of Agriculture, contribute the following note on certain modern methods for the preservation of milk :--

The Preservation of Milk.

Of the methods employed for the preservation of milk those involving the use of heat are amongst the most important. Such methods may generally be classified into two main groups :—

(1) Those involving the use of a moderate degree of heat and aiming only at a partial destruction of the bacteria present. Methods of this type are generally known as pasteurisation methods.

(2) Those involving the use of a high temperature and aiming at the complete destruction of the germs present in the milk. Such methods are classified as sterilisation methods.

In judging the efficiency of any method for the preservation of milk involving the use of heat, the following points have to be considered :—

(1) The destruction of disease-producing organisms.

(2) The effect on the flavour of the milk and on the rising of the cream.

(3) The effect on the composition of the milk and its vitamin and enzyme content.

The purpose of this note is to give a *resumé* of the present position of our knowledge on these points with regard to certain modern methods of pasteurisation and sterilisation, and to indicate possible lines for further investigation.

As regards methods of pasteurisation, the general consensus of opinion is now in favour of the so-called "Holder" process, in which the milk is maintained at a temperature of 63° C. (145° F.) for half-an-hour. This method brings about a substantial reduction in the bacterial content of the milk, and Schorer, Rosenau and others have shown that it destroys the common disease-producing bacteria, including the organism of tuberculosis. Ayers and Johnson state that an advantage of this method over the older method of heating momentarily at a higher temperature is that the percentage of lactic acid bacteria is increased. Consequently, milk treated in this way is not so liable to undergo undesirable changes after pasteurisation. There is general agreement that pasteurisation by the "Holder" process, if properly carried out, produces no objectionable cooked flavour. According to Harding the rising of the cream is not appreciably affected unless the temperature of pasteurisation exceeds 144° F. With regard to the effect on the composition of the milk, Jensen has found that this method of treatment has a less destructive effect on the proteins than is the case with the older methods, and he consequently recommends it for the treatment of milk for infants and for cheese-making. There is evidence to show that the effect on the enzymes is comparatively slight. So far as we are aware, no actual samples of milk pasteurised by the "Holder" process have been examined for their vitamin-content.

Up till quite recently comparatively little use has been made of the process of sterilisation of milk on a commercial scale, owing to the undesirable changes resulting from the exposure to the high temperature necessary for the complete destruction of the bacteria present. In the course of the last few years, however, a process has been devised by Nielsen which is said to obviate these difficulties. In this method the milk is passed through a series of steam-heated tubes and its temperature raised momentarily to 130–135° C., the milk being kept under pressure in order to prevent boiling. This is followed by rapid cooling and filling by a special appliance into sterile containers. It has been shown by Jensen that under the conditions prevailing in this method of treatment even very resistant bacterial spores, which have been artificially added, are destroyed in forty to fifty seconds and the milk is rendered sterile, in which condition it will, of course, keep indefinitely. By keeping the milk under pressure during the heating process and by means of the subsequent rapid cooling the natural flavour is retained and browning is prevented. No data are available as to the effect of this process on the proteins and enzyme and vitamin-content of the milk.

In view of the recent work on the stability of vitamins, the question of the vitamin-content of milk treated by the "Holder" and Nielsen processes would, in our opinion, well repay investigation. It is now fairly well established that the vitamins A and C, while readily inactivated by heating in presence of air, are moderately stable under the action of heat when air is absent. For example, experiments of Hopkins demonstrate that in the absence of air the fat-soluble vitamin A in butter can be heated at a temperature of 120° C. for some time without an appreciable diminution in its growth-promoting power. According to Dutcher, Harshaw and Hall, vitamin C in fresh orange juice is not destroyed by pasteurisation for thirty minutes at 63° C. in closed vessels, while Delf has found that in some cases this vitamin can resist a temperature as high as 130° C. when air is excluded. In a recent paper Zilva states that decitrated lemon juice can be heated for two hours at 100° C. in absence of air without showing any apparent reduction in its content of vitamin C. Vitamin B is not affected by presence of air, and is fairly resistant to heat. Most investigators are agreed that it is very slightly affected by exposure to a temperature of 100° C. for a period of one to two hours, whilst some observers find little loss in growth-promoting potency after an exposure of two hours to a temperature of 120° C.

Now in the Nielsen process the milk is heated in absence of air for a very short time and then rapidly cooled. One would, therefore, expect that little or no change in the vitamin-content would occur. In the "Holder" process pasteurisation in bottles is recommended, particularly by Hammer and Hauser, and by Weigmann, in order to avoid recontamination of the milk subsequent to pasteurisation. Under these conditions the possibility of aeration and consequent inactivation of vitamins would be very greatly reduced. Investigations along these lines should therefore yield valuable and interesting results.

Basic Slags and Rock Phosphates: Reviews.

Basic Slags and Rock Phosphates (Cambridge Agricultural Monographs). By Dr George Scott Robertson. Pp. XVI. + 120. Cambridge University Press, 1922. 14s. nett.

In an article published in this *Journal* in July 1921, attention was directed to the great changes which had taken place within the last ten years in the methods of steel-making. The older "Bessemer Process" has been very largely supplanted by the "Open Hearth Process," which yields quite a different type of slag. It was also pointed out that, unlike superphosphate, basic slag is not manufactured specially for the farmer, but is merely a by-product in the process of steel-making, and that neither in quality nor in the amount produced are the requirements of the agriculturist directly considered. In consequence of this change the results of the older experiments with basic slag are not applicable to the modern slags now being produced.

Dr Scott Robertson has, therefore, performed a service of much importance to farmers in carrying out a detailed series of experiments to ascertain the value of the new slags as compared with the old. The experiments were commenced in 1915, and were carried out on permanent grass land on the heavy clay soils in Essex. The experiments were not confined to a comparison of the old and new types of basic slag, but included also tests of the "Rock Phosphate" rendered available in recent years by the development of the extensive deposits of this material in the Pacific Islands. The "Open Hearth" slag varies considerably in composition, but, generally speaking, is poorer in phosphate and less soluble than the old basic slag. Dr Robertson's experiments show that when applied in equivalent quantities the open hearth (non fluor-spar) slag gives on the whole the same results as the old basic slags. The poorer types of "Open Hearth" slags, especially those slags to which fluor-spar was added during the manufacturing process to make them more liquid, give less satisfactory results.

One of the most interesting and important of the results obtained by Dr Robertson is that showing the value of ground rock phosphate; this gave results where there was a good rainfall which compared favourably with those obtained from high-grade basic slag.

Dr Robertson has not confined himself to merely recording the yields obtained from the various slag and rock phosphates, but has investigated their effect on the herbage, moisture content and temperature of the soil. Their effects on the accumulation of nitrogen and on the "lime requirements" of the soil have also been studied.

Dr Robertson's monograph is the most notable contribution to the literature of phosphatic manures which has been made in recent years. The results are clearly set out and amply illustrated with tables and diagrams. Previous work on the subject is reviewed, and there is an adequate list of references.

A technical paper of much importance on "The Composition of Basic Slag" was recently read before the West of Scotland Iron and Steel Institute, and is now issued as a reprint from the Institute's *Journal.* The writers are Dr Scott, of the Central Technical School, Stoke-on-Trent, and Mr D. N. M'Arthur, of the West of Scotland Agricultural College. The paper contains the results of microscopic and chemical examinations of a number of slags from basic steel furnaces, both open-hearth and Bessemer. In their investigations the authors have kept in view the elucidation of problems in connection with the utilisation of basic slag for agricultural purposes.

Scottish Agricultural Text-Books: Review.

The Scottish Series of Junior Agricultural Text-Books. Edited by Professor James Hendrick, Aberdeen University. Publishers: Messrs W. Green & Son, Limited, Edinburgh.

The main purpose of this series of agricultural text-books is to meet the needs of the young people who attend continuation classes or extension lecture courses in agricultural science, conducted by Education Authorities or by Agricultural Colleges. They make a still wider appeal to all engaged in practical agriculture who have not had the time or the opportunity to take any course of scientific training; and they claim special attention from Scottish readers inasmuch as they are to be written "by northern experts in a northern atmosphere," and are to keep in view northern conditions in regard both to agricultural practice and to educational requirements.

These are eminently laudable aims. The provision of agricultural science teaching in continuation classes is gradually being extended, and text-books of this character, if used with discretion, will help to systematise and make more permanent the instruction given in class. Without doubt, too, for the Scottish student the interest and value of the subject-matter will be enhanced by references to familiar farm practice.

Farm Book-Keeping. The first of the above-mentioned series to appear is a text-book on Farm Book-Keeping, by John Kirkwood, N.D.A., N.D.D., Lecturer on Book-Keeping in the West of Scotland Agricultural College.

Having in mind the aim of the series the author has—probably wisely—confined himself in Part I. to a brief exposition of the theory of double entry as applied to farming transactions, and in Part II. to a simplified system of recording such transactions with the minimum amount of clerical work. Cost accounting is not dealt with.

The exposition of the theory of double entry might have been improved by more insistence on the reason for making an entry on one or other side of an account. Merely to repeat the jargon—"Debit losses; Credit gains"—is not to explain why a profit in a stock account, for example, is entered on the debit side. It should be made clear that the entry is so made because value has been put into the stock by the agency of the owner.

The term Capital is rather strictly defined: it is really *net* capital that is found when liabilities are subtracted from assets. Some confusion also is shown in the treatment of rent outstanding: the introduction of "Landlord" is unnecessary.

Apart from minor defects, the selection and the working out of the examples are well done, and no one could work through these without obtaining a fair knowledge of principles and considerable deftness in practice.

The chapter on Valuation is exceptionally good, and that on Income Tax concisely and lucidly summarises the options available and the procedure to be followed in each case. The vexed subjects of private expenses, the home consumption of farm produce, unpaid work done by members of the family, and board of servants are all adequately treated, and these sections should be carefully read by farmers.

The simplified system set forth in Part II. is that of the classified Cash-Book, with the necessary summaries. It is clearly demonstrated, and can be cordially commended to all who want only the simplest form of farm accounting.

Publications of the International Institute of Agriculture.

THE work of the International Institute of Agriculture deserves to be more widely known in Scotland. The Institute was set up as the result of an International Conference held in Rome in 1905 and is now supported by the Governments of about fifty countries, including Great Britain and Ireland, India and most of the self-governing Dominions and Colonies of the British Empire.

Monthly bulletins are issued by the Institute dealing with agricultural statistics of the world, economic and social intelligence, and agricultural intelligence and plant diseases. In addition to these periodical publications, reports and monographs on special subjects are issued from time to time. The following notes refer to some special publications that have recently been issued.

(1) *International Year-Book of Agricultural Statistics 1909 to 1921.*—This is the first year-book of the Institute to include data for the years following on the great war. The statistics given include the total area and population of every country, with subdivision of the territorial area on an agricultural basis; the area

and yield of the various crops; international trade, prices and freights; and the production of fertilisers. Tables are also given to show the rates of money exchange over a period of years and the equivalents for the units of weights, measures and capacity employed in Great Britain and the United States, expressed in the corresponding units of the metric decimal system in use on the continent of Europe.

The notes and tables are in French and in English and the volume provides a most comprehensive survey of world agriculture.

(2) *Oleaginous Products and Vegetable Oils.*—This publication is, so far, issued only in French (*Produits Oléagineux et Huiles Végétales*), but it is proposed to issue an addition in English if the demand from English-speaking countries should justify the expenditure involved. The volume is divided into two parts. The first is drawn up on the basis of countries. The cultivation of oil-bearing plants and the trade in their products is examined for each country, and the modifications that have taken place during the development of the uses of various articles are dealt with so far as statistical data exist. The second part of the volume gives trade data regarding oleaginous products and vegetable oils.

The researches were limited to the following crops:—cotton, linseed, hemp, rape seed, mustard seed, sunflower, poppy seed, castor oil, ground nut, soya, sesamum, olive, cocoanut and oil palm products.

(3) *Utilisation of Waste Products and Residues.*—This monograph is published in French, but the question of an edition in English is at present under consideration.

The report deals with the measures taken in various countries for the collection of waste products and their conversion for use in the form of food for human beings and live stock, or for the manufacture of artificial manures, etc. The subject was one of great importance during the war and the measures taken in the countries most seriously affected by the diminution of supplies are described in detail. It is important that the experience gained during the period of the war in the utilisation of waste products and residues should not be lost and the volume will be of much value to research workers. The question of improvement in the systems of manufacture, with a view to reducing waste, is also dealt with, and this side of the question will be of particular interest to manufacturers and millers.

(4) *International Year-Book of Agricultural Legislation, 1922.* The eleventh volume of this year-book is now ready. In accordance with the method followed in previous years the more important legislative provisions are printed *in extenso*, translated into French. Two indices make the year-book easy to consult, the first a chronological index, by countries, and the second a subject index. There is a full table of contents in English. An analytical introduction in English briefly describes the laws and orders published in full in the volume, thus giving a general idea of the effect of the agricultural legislation promulgated in the various countries of the world in the year 1921.

(5) *Recueil de Coefficients et Equivalences.*—This French publication is divided into three parts. Part I. contains coefficients for the conversion of the various measures and moneys of the different countries into their equivalents expressed in units of the metric system. Part II. contains forty-eight tables of the principal English and American measures with their equivalents in the decimal system and *vice versa.* Part III. is composed of seven tables in which are comprised the formulæ for reducing, on the basis of the rate of exchange, the original quotations of each country to the monetary units and weights of other countries.

(6) *The "Landschaften" and their Mortgage Credit Operations in Germany 1770–1920.*—The *Landschaften* are the oldest land credit institutions in Germany and the principles upon which they are based have been adopted in several other countries in the organisation of land credit. No general account of the *Landschaften* has been published in recent years and the present study aims at supplying this need. After outlining the historical development of the *Landschaften,* it describes their organisation and working. Complete statements are then given of the issue and withdrawal of land bonds by the *Landschaften* during their 150 years of working, of the variations in the market price of these bonds, and in the rate of interest paid upon them as well as of the lands mortgaged. These statements will be of great value to persons interested in land credit, but some parts of the study, such as those relating to dismortgaging (which is often carried out by means of life insurance policies) have an even more general interest and will be of value to economists, to bankers and to all engaged in the business of insurance.

An English edition of this publication has recently been issued.

(7) *Commerce International du Bétail et de ses Dérivés, 1921 (French Edition only).*—The object of this volume is to show the commercial movement in different countries, during and after the war, of certain species of live-stock (horses, donkeys and mules, oxen, sheep, goats and pigs) and of the principal products of these animals, namely, flesh, fat, milk, butter and cheese, skins, hide and wool. This publication is divided into two parts—the first part comprises combined tables relating to the different species of animals and to their products; the second part deals with the details concerning imports of the principal countries. All the tables embrace the commercial movement of the five-year period 1915–1919.

Copies of these publications may be purchased from the Ministry of Agriculture and Fisheries, Whitehall Place, London, S.W. 1.:—

International Year-Book of Agricultural Statistics, 1909 to 1921, price 8s.

Oleaginous Products and Vegetable Oils, price 7s. 6d.

Utilisation of Waste Products and Residues, price 8s.

International Year-Book of Agricultural Legislation, 1922, price 12s.

Recueil de Coefficients et Équivalences, price 2s.

The "Landschaften" and their Mortgage Credit Operations in Germany, 1770–1920, price 2s.

Commerce International du Bétail et de ses Dérivés, 1921, price 3s.

General Assembly of the International Institute of Agriculture.

THE Sixth General Assembly of the International Institute of Agriculture was held in Rome from 8th to 16th May 1922, and was attended by representatives of fifty-one different countries. The British delegation consisted of representatives of the Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland. Ireland was not represented on this occasion. The largest delegations were those of France, Italy and the United States of America.

The first matter that arose was a motion by the United States delegation, that English should be recognised equally with French as the official language of the Institute. After a long discussion it was agreed that both French and English should be used in the discussions and resolutions of the Assembly, while the publications of the Institute should be printed in the following languages:—English, French, German, Italian, Portuguese and Spanish, subject to the prospect of each edition paying for its cost. Formerly, all publications were automatically issued in French, certain selected publications being in addition issued in English, Italian and Spanish, and (up to the war) in German, under special financial arrangements. The effect of the new arrangement is to put other countries on a more equal footing with French-speaking countries.

The most important business of the Assembly was the consideration of finance and reorganisation. As regards finance it was agreed to recommend the adhering Governments to pay for the years 1923 and 1924 the same supplementary contributions as were paid for 1921 and 1922. This scheme was devised for the purpose of removing as far as possible the anomalies created by the chaotic state of the European exchanges. In the meantime the Permanent Committee is charged with the duty of preparing a scheme for a permanent adjustment of the contributions made by the adhering Governments.

In view, however, of the fact that no additional resources were immediately available, it was recognised that any extension of the Institute's activities could be secured only by making reductions in other directions. The British delegation, therefore, submitted a resolution to the effect that the Bulletins of Agricultural Intelligence and Economic and Social Intelligence should be issued quarterly instead of monthly; that some of the information given in the monthly Statistical Bulletin should be issued less frequently; that the free distribution of the Institute's publications should be curtailed; and that efforts should be made to increase the sales of these publications. The savings thus effected would enable the Institute to issue reports and monographs on special subjects, to improve its bibliographical work, and to make more use of the telegraph in collecting and distributing urgent information. This resolution was carried after considerable discussion. A number of resolutions were also passed relating to details of the work of the Bureaus of Statistics, Agricultural Intelligence and Economic and Social Intelligence.

The Assembly expressed its satisfaction with the invitation that had been extended to the Institute, in common with the League of Nations and the International Labour Office, to send to the conference at Genoa a delegation of experts with the object of furnishing the conference with any information relating to agriculture that might be required. War and post-war conditions have everywhere brought into prominence the question of agricultural production, and those who have followed the development of the Institute are convinced that if it continues to receive adequate support from the adhering states it will play a part of increasing importance in international affairs.

Registration of Stallions.

THE season for the licensing of stallions under the Horse Breeding Act, 1918, closed at 31st July last. Under this Act, which came into force on 1st January 1920, it is illegal for a stallion of two years of age or over to be travelled for service or exhibited on premises not in the occupation of the owner of the stallion with a view to its use for service, unless the stallion is at the time licensed under the Act. It may be of interest to record the results of the Board's operations in the administration of the statute for the three years during which it has been in force. The following table shows the number of applications for licences received each year in respect of the various breeds or types of horses and the number of licences issued in each case :—

BREED.	1920		1921		1922.	
	Number of Applications	Licences Issued	Number of Applications	Licences Issued	Number of Applications	Licences Issued
Clydesdale . .	750	674	707	671	589	556
Highland Pony .	43	42	42	42	44	44
Shetland Pony .	47	47	40	40	48	48
Hackney . .	16	15	18	18	15	15
Thoroughbred .	8	8	9	8	5	5
Percheron . .	1	1	1	1	1	1
Shire . . .	1	1	3	3	...	...
Trotter . .	3	1	2	2	5	4
Hunter . .	1	1	...	...	...	...
Welsh Pony .	1	1	...	...	...	...
Weight-carrying Pony . .	1	1	...	...	...	...
TOTAL .	872	792	822	785	707	673

The difference between the number of applications received and the number of licences issued represents the number of licences refused in each case. The following diseases or defects are prescribed in the regulations made under the Act as rendering a stallion unsuitable for service of mares, namely:—Stringhalt, Shivering, Roaring and Whistling, Sidebone, Bone Spavin, Ringbone, Cataract, Defective Genital Organs, Navicular Disease and Defective Conformation. During the three years licences were refused on the following grounds:—

	1920	1921	1922
Stringhalt . . .	18	4	5
Shivering . . .	4	1	2
Roaring or Whistling .	24	10	10
Sidebone . . .	9	10	8
Ringbone . . .	4	...	2
Bone Spavin . . .	5	3	1
Cataract . . .	2	1	...
Defective Genital Organs	8	4	3
Navicular Disease . .	1	...	...
Defective Conformation .	5	4	3
	80	37	34

From the above figures it will be seen that the number of applications has considerably decreased since 1920. This is accounted for, to some extent, by the reduced demand for horses during the last two years and the consequent fall in prices. A satisfactory feature, however, is the reduction in the percentage of applications refused. While unsound horses may be retained on the owner's premises for service, the effect of the Act is that owners of licensed stallions are protected in large measure from unfair competition, and the chances of injury to the respective breeds of horses, and to the horse-breeding industry in general, are very much reduced.

The provisions of the Act generally are well known throughout Scotland, and only in one case were proceedings taken against the owner of a stallion for contravention of the Act by travelling a horse for service without a licence. The owner concerned was convicted and fined £10. Attention is drawn to the fact that persons who are in charge of stallions travelling for service are liable to be called upon to produce their licences. The necessity for having the licences available for production by the grooms did not seem to be generally understood at first, but later fewer contraventions in this respect have been reported. It is within the power of the Board's inspectors, and also of the police, to require the production of licences for any stallions they meet on the road.

Agricultural Conditions.

THE weather during June, except for some warm days in the early part of the month, was rather broken and cold, and the growth of all crops was slow. The conditions during July and August were also very unsettled, and the temperature in most parts was unusually low for this period of the year. Rain was frequent and in some instances heavy, while almost everywhere there was a great lack of sunshine. The effect of the cold, sunless weather has been to delay the ripening of the grain crops and, as a result, harvest is later than usual. The rains, however, have maintained the pastures in good condition, and were also beneficial to the potato and root crops. In some districts the hay harvest had not been secured at the end of August, but the crop does not appear to have been damaged to any extent.

The wheat crop is generally healthy and vigorous, though in South-West Forfar, South-West Perth, Berwick and North-East Fife some fields are affected with rust. Cutting had commenced in North-East Forfar and South-East Perth during the latter part of August, but it was not expected that operations would be general before the second week of September. The harvest prospects are fairly satisfactory on the whole, and average yields are expected in most of the districts in which the crop is principally grown; in South-West Forfar and North-East Fife it is estimated that the yield will be below the normal by 10 per cent.

The barley crop is generally stated to be in good condition, and straw will be plentiful. Cutting did not take place to any extent during August, but it was expected that a start would be made in most districts during the first week of September. Yields more or less below the average are expected in the south-western counties and in Stirling, North-West Lanark, South-West Fife and Berwick, but elsewhere the yield per acre will probably be about normal. Bere is ripening slowly, and promises to be an average crop, except in Caithness.

The reports on the oat crop are more varied, and on the whole less favourable than in the case of wheat and barley, and taking the country as a whole the yield is expected to be below the average. In many districts the fields were still green at the end of August, while on wet and heavy soils the crop was stated to be thin. Harvest had commenced in August in Forfar, South-East Perth, North-East Fife and Roxburgh, but in the majority of districts a beginning was not made until the second or third week of September.

Beans were generally reported to have made good progress during August. There is a good length of straw, and it is believed that the total yield will be above the average.

Potatoes promise to be a satisfactory crop, and good or average yields are expected in most districts. Complaints of disease have been received from North-East Aberdeen, Orkney, Islay, Jura, Ayr and Wigtown; leaf curl is in evidence in North-West Aberdeen, and "Blackleg" in Shetland.

Turnips and swedes have improved greatly since the beginning of August, and the prospects of the crop are much brighter; in the case of late-sown fields the braird was unusually late in appearing, and growth has been slow. Average yields or over are expected in South-West and Central Aberdeen, South-West Forfar, Fife, the Lothians, Stirling, Renfrew, the northern counties, Shetland, the Western Islands and most districts of Argyll; elsewhere it is anticipated there will be a deficiency varying from 5 to 10 per cent. Mangolds have recently made satisfactory progress, but the crop will probably prove to be below the normal in Ayr, the Lothians, Berwick, North-West Lanark and South-West Perth.

Small fruits have given average yields in most districts; in North-West Aberdeen, however, strawberries were a disappointing crop. Plums were practically a failure in Wigtown, but in North-West Lanark and South-East Perth the yields are good or average; apples and pears are a heavier crop than usual.

Grazing cattle are stated to have thriven well, but in some cases their progress has been affected owing to the cold, wet weather. Dairy cows are doing moderately well; in several districts, however, the milk yield is decreasing, and extra feeding has had to be given to maintain the supply. Sheep of all classes are reported to be in good or in fair condition, but lambs are not so well grown as at this time last year.

The supply of regular workers is generally adequate for requirements, but in North Ayr dairy workers are rather scarce. Casual labour is difficult to obtain in Skye, but elsewhere harvest hands are reported to be plentiful.

RECENT PERIODICAL LITERATURE.

The majority of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins, and to the original publications quoted therein, may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

The Transmission of the Character "Resistance to Heterodera schachtii" in Barley. *H. Nilsson Ehle*, *Hereditas.*—The greater or less resistance of different varieties of barley to the attacks of *Heterodera schachtii* (eelworm) is of considerable importance in rotations where barley is followed by oats, for, as is well-known, the latter is much injured by these parasites.

If the barley belongs to a resistant type, the number of the nematodes present in the soil decreases, but if, on the other hand, it happens to be of a susceptible variety, the pests increase greatly and constitute a serious danger for the oat crop which follows the barley.

Oats sown after Chevalier (resistant) produce a crop exceeding by 59 per cent. that obtained when they are preceded by Prinsess (very susceptible).

The degree of resistance possessed by barleys is therefore of the greatest practical and economic interest.

From this point of view, they may be divided into two categories, viz., resistant (or nearly resistant) and susceptible. No intermediate degrees and values are found between the two extreme types, such as occur in similar cases; this would seem to show that resistance to *Heterodera* is due to the presence and action of a single genetic factor.

In order to study this question, the author crossed Chevalier I. and Chevalier II. (both resistant varieties) with Prinsess (susceptible). The F_1 hybrids proved resistant, therefore this character appears to be dominant.

In the F_2, though the experiments had been carried out under somewhat unfavourable circumstances, a large preponderance of resistant plants was obtained.

Some of the lines of the F_3 were resistant, others susceptible, and others again were composed of susceptible and resistant individuals, with a preponderance of the latter.

The existence of one distinct genetic factor makes it possible to increase the amount of resistance by means of suitable selection and crossing, but it must not be forgotten that yield must be combined with resistance. As a rule, the most resistant types are the least productive.

Copper Sulphate in the Control of the Field Poppy in Wheat Fields. *Vilcoq*, *Comptes rendus des Sciences de l'Acad. d'Agric. de France.*—The results of experiments carried out for the purpose of determining whether copper sulphate had a strong toxic action upon the field poppy (*Papaver Rhoeas*), and if so, the strength of the copper solution required to destroy it.

Some plots of ground belonging to the Agricultural College of Chesnoy (Loire), in which the wheat succeeding mangels was infested with field poppy were sprayed with increasingly concentrated solutions of copper sulphate (3, 4, 5 and 6 per cent.).

By this means it was found that 3 and 4 per cent. solution had hardly any effect, but that *Papaver Rhoeas* is not insensible to 5 and 6 per cent. solution; the latter is the highest concentration that can be used for fear of damaging the wheat. A 6 per cent. solution blackens and destroys the lower leaves of the poppy; the plant, however, continues to grow, though less vigorously, and its development is but slightly hindered.

Potato Improvement by Hill Selection in U.S.A. *G. Stewart*, *Utah Agric. Coll. Expt. Stn. Bull.*—In 1911, a number of the highest and also of the lowest yielding hills were selected and isolated from the Majestic, Bangor and Peerless varieties, then being grown at the Utah Experiment Station. In 1912 the tubers from each hill were cut into sets weighing approximately 2 or 3 oz., and containing on the average two eyes. The sets were planted about 15 inches apart with rows 3 feet apart. At harvest time each hill was dug separately, and the tubers isolated and later weighed, etc. About half of the best hills from the best progeny-rows and a few high yielding hills from other good rows were chosen. In poor selections the lowest-yielding hills were used as seed. This method of selection was continued from 1912 to 1919, and is being continued still further and supplemented. Except that the poor selections were discarded in 1916, and after 1914, Bangor and Peerless stocks were also discarded on account of inferiority in yield.

The experiment was so conducted as to avoid selections for somatic characters, and to secure selections for gametic qualities. This was done by growing all the best strains for two or more years in order to get a progeny test of the power of a strain to transmit its desirable qualities to the succeeding generations.

By 1915 the high-yielding strains yielded an average of 301·03 bushels per acre, as compared with 179·30 bushels per acre for unselected. From 1915 to 1920 the selected strain has outdistanced the unselected stock of the same variety by more than 100 bushels per acre, except in 1919 when there was a difference of only 29·6 bushels (this wide fluctuation may have been due to the extremely unfavourable growing season of 1919). In 1920, however, the superiority of the selected strains manifested itself, outyielding the unselected strain by 168·6 bushels.

Taking the six-year average, 1915-1920, the acre yield of the selected strain was 60·9 per cent. greater than that of the unselected, and the average size of tuber 24·4 per cent. greater.

The germination of the selected strain is more rapid, the stand is better, the growth thriftier, and diseases less apparent than for the unselected potatoes of the same variety.

Treatment of Potato Sets. *I.—E. W. Cooley, Potato Magazine. II.—E. Schribaux, Comptes rendus des Sciences de l'Acad. d'Agric. de France. III.—W. H. Taylor, New Zealand Jour. of Agric. IV.—C. Tice, British Columbia Dept. of Agric. Bull.*—Some growers declare that seed potatoes should be cut lengthways, so that each piece will contain a part of the seed end of the potato, confident in the fact that the seed end sprouts sooner than the stem end or any other part of the potato, and that the sprouts will be stronger and the yield larger. Others assert that the seed end should be cut off and thrown away, as they consider that instead of sending out one or more strong vigorous shoots, the seed end will produce a number of small weak ones. Then again, some of the most successful potato growers plant nothing but the whole potatoes. Experiments made in various countries are therefore well worth consideration, in order to come to some more definite conclusion as to the best method to adopt.

I. In the United States, as a result of observation and experiments conducted in Maryland, Michigan, Colorado, etc., it was concluded that most of the eyes on a potato have equal value for seed purposes, and at Michigan Agricultural College Farm it was demonstrated that the stem end piece bore as vigorous sprouts when separated from the seed ends as the seed ends themselves, and when all other conditions were equal, the individual hill yields were also approximately the same. While it is true that the size of the seed piece is more important than the number of eyes, the experiments seem to indicate that each seed piece should contain at least two eyes.

A number of seed potatoes from high yielding hills were cut so as to give pieces of approximately the same weight but with varying numbers of eyes. Twenty-one pieces containing one eye per piece showed 61 per cent. germination; four pieces with one and a half eyes per piece showed 75 per cent.; twenty pieces with two eyes per piece, four with two and a half eyes per piece and seven with three eyes per piece, showed 100 per cent. germination. The average quantity of cut potatoes used amounted to 10 bushels per acre, but experiments conducted on 360 farms in the State of New York showed that the yield was from 85 to 100 bushels more per acre when 18 bushels of seed were planted than when 10 bushels were used.

II. M. Schribaux draws attention to the evident disadvantages connected with cutting sets, and then proceeds to indicate the advisible method to adopt in order to compare the growth and yield to be obtained from cutting or planting whole, in consideration of the fact that at the Académie d'Agriculture d'Angers information has been received recommending the cutting method both from the economical standpoint and as regards yield.

As regards the disadvantages, emphasis is laid on the fact that certain varieties (*e.g.*, Richters' Imperator) when cut, are liable to rot. This is, however, an exception, and there is no reason to exaggerate the physiological dangers attached to cutting which can to a large extent be lessened and even eliminated. Care should be taken to plant only sets which have been exposed to the air for several days. Secondly, extra labour is involved in the cutting process. There is also a risk of waste through drying which applies also to the period following planting, as cut sets are less resistent to drought, defective cultural operations, etc., than whole sets. Even under favourable conditions, success is at present uncertain, and the author considers that this is due to the lack of knowledge concerning (*a*) the advisable average weight of the cut sets; (*b*) the best system of planting to employ.

The author suggests the following plan, but considers that unless the greatest care is taken to observe the details, it should not be attempted, seeing that it is the relative and not the absolute yield which it is desired to determine :—

WHOLE SETS.		CUT SETS.					
		Small about .35 oz., each with two eyes.		*Medium* about .7 oz.		*Large* about 1 oz.	
Distance apart.	Number of plants per sq. yd.	Distance apart.	No. of plants per sq. yd.	Distance apart.	No. of plants per sq. yd.	Distance apart.	No. of plants per sq. yd.
cm.		cm.		cm.		cm.	
50 × 40	5	50 × 14	14	50 × 20	10	50 × 25	8
50 × 50	4	50 × 18	12	50 × 30	7	50 × 33	6
50 × 60	3	50 × 25	8	50 × 40	5	50 × 50	4

The cutting of small sets above recommended is the method adopted with success by M. Maisonneuve at Angers, who, after having removed a good third of the tuber where there are few eyes, cuts the remainder into six or eight parts according to the number of eyes. As regards the large sets, M. Schribaux recommends a similar removal of the lower inferior part of the tuber and cutting vertically the remainder into equal parts.

With reference to planting, the author remarks that the cut sets should be planted less deeply than the whole sets ; about 3 to 4 cm. deep for the small, 4 to 5 cm. for the medium and 5 to 8 cm. for the large.

At harvest time, note should be made of the failures, the average number of shoots per plant, the yield per plot and per clump, the average weight of tuber and the proportion of large, medium and small. During these experiments it is particularly important to note carefully all circumstances which tend to influence the quality of the yield in one way or another.

III. In New Zealand it has been proved by growers that potatoes may be roughly divided into two classes, viz., round varieties on which the eyes are nearly all active at the same time, and kidney shaped (occasional rounds) that have a decided rounded end. If the former be planted with all the buds intact, a large proportion of them will grow into shoots. The latter behave differently. One, two or three buds start before the others, aad if nothing happens to destroy them they will produce a plant ; the remaining eyes will remain dormant. If the tops of these shoots are injured by frost, they make fresh growth lower down. This naturally results in a reduction in the crop, but the latter may still be profitable. A second frost may occur which will entirely destroy the first tops. Other buds, that probably have already broken but not made much headway, then break through, and may produce a crop just sufficient to pay costs. This explains why no disbudding is done. The seed tubers are not cut, as that would cause decay, and the second set of buds would not be able to continue growth.

The common belief that all the eyes on a set will produce shoots, and that disbudding is necessary to prevent an overplus of shoots which would give small potatoes is, therefore, contradicted.

IV. Experiments conducted in British Columbia support the claim made by M. Schribaux that in districts where the land is wet or poorly drained whole potatoes are preferable to cut sets, since the latter rot easily. Also cut sets are more subject to disease, and sprout later. However, the percentage of marketable potatoes has been found in this case to be smaller when whole sets are planted than with cut sets.

When cut sets are used, a 2-oz. piece has been usually found the best. This statement is fully borne out in an experiment carried out by Dr Zavitz at Guelph. Sets were planted for five years weighing $\frac{1}{16}$ oz., $\frac{1}{8}$ oz., $\frac{1}{4}$ oz., 1 oz. and 2 oz. ; one eye was left in a piece and the pieces planted 1 ft. apart in the rows. There was a variation in yield from 47·5 bushels to 173·9 bushels for 2 oz. of seed. Subtracting the amount of seed used, the former gave 46·2 bushels and the latter 132·7 bushels. The system of cutting out the eyes of the set is not recommended, as the author considers there is not enough plant food present to support the young shoot till it develops a root. It is usually conceded that two eyes to a set gives better results than even one or three eyes. Where a large number of eyes are present the percentage of marketable tubers is greatly reduced ; this was found especially true when the seed-end of the potato was planted, although the potatoes thus obtained were earlier.

Utilisation of the Potato as Stock Feed, Source of Alcohol, etc., Manufacture of Dehydrated and Dried Pressed Potatoes, Flour and Starch. *H. C. Gore, New Jersey Dept. of Agric., Bull.*—The necessity of providing some outlet for surplus potatoes during exceptionally favourable seasons, has led to the utilisation of potatoes for various purposes. The author here reports the progress made in the United States in this respect :—

STOCK FEED.—One of the difficulties of profitable feeding of potatoes is the necessity of keeping an adequate supply in sound condition throughout a long period. It now seems probable, however, that this difficulty can be overcome by the practice of ensiling ; potato silage is eaten freely by cattle and can be used also for pigs ; it appears to be as palatable as the best maize silage.

An experiment was made at the Dairy Farm at Beltsville comparing the gain in weight of six cows, three fed with potato silage and three with maize silage for thirty days, at the end of which time the rations were reversed, allowing ten days to make the changes and extending the length of the experiment another thirty days. It was found that, when fed on a ration containing a large proportion of maize silage, the three cows produced 3331 lb. milk, containing 164 lb. butter-fat in sixty days, while they gained 138 lb. in weight. When fed on a ration in which the maize silage was replaced by an equal weight of potato silage the milk production in the same period was 3269 lb., containing 158 lb. butter fat, while the gain in weight was 157 lb.

MANUFACTURE OF DEHYDRATED POTATOES.—There is at present no wide market for dehydrated potatoes (dried) although during the war the use was considerable.

MANUFACTURE OF DRIED PRESSED POTATOES.—The equipment needed for converting the potatoes into dry feed is easily constructed ; the washing is done in a continuous paddle machine of the type used in washing potatoes for starch making. From the washer the potatoes are ground until liquified and passed into a stock box, provided with a gate valve, and then passed into the hydraulic press as needed. About 1 ton of ground potato is pressed at one time, the process taking from fifteen to twenty minutes. The yield of dried pressed potato is about 20 per cent. of the weight of potatoes.

MANUFACTURE OF ALCOHOL.—The work carried on under the direction of Wiley (Bureau of Chemistry, U.S.), started in 1910, permits the following estimates to be made as to the cost of alcohol manufacture in small plants :—Approximately 0·66 gallons of 180 proof alcohol can be produced from 1 bushel of potatoes of 14 per cent. starch content. The potatoes used daily will weigh about 8000 lb. to obtain 100 gallons per day, and this necessitates the mashing of 320 lb. of malt.

A summary of the cost per gallon of alcohol (180 proof) is given as follows (in dollars) :—Raw material 0·279, investment 0·124, operating 0·159. Total $0·562.

There will be about 1000 gallons of spent mash worth $53·3, or $0·04 per bushel of original potatoes, or $0·053 per gallon of alcohol produced ; this makes on an average the net cost per gallon $0·509.

This may be compared with the cost of manufacturing alcohol from potatoes in a plant of German manufacture, in which alcohol of 180 proof is produced at the rate of 263 gallons per day, and the total cost amounts to $0·478 (*i.e.*, the net cost per gallon $0·425).

Owing to present conditions these figures would now be considerably increased, and whether or not the production cost can be decreased still remains an open question for further experimentation.

POTATO FLOUR.—The most important process developed is a steam drying method in which the potatoes are converted into potato flakes which are later milled into flour.

The raw potatoes are washed in a machine commonly used in distilleries or starch factories and then conveyed by an elevator to a steamer erected over the drying apparatus, where they are cooked by means of low pressure steam. After steaming, the potatoes are allowed to fall by gravity into hoppers and through the emasculators, where they are reduced to pulp, and in this shape are forced on to the drying drum. These drums turn in opposite directions at five revolutions per minute. The heat dries off the moisture of the pulp and leaves a firm mass that is scraped off by means of knives set parallel to the main axes of the drums. The dried mass falls into a spiral transformer fitted with revolving arms where it is broken into flakes and conveyed to the packing room. Numerous factories are now established in various American States, and the capacity of a single unit plant is about 8000 lb. per day. The flour is used principally to improve the quality of bread, but has other baking uses. There is, however, still much to be done in developing this industry. The price at present is about nine cents per lb. in wholesale quantities. The author considers that this flour does not possess the same glutinous quality as rye and wheat flour, but has peculiar properties as yeast food and a good flavour.

POTATO STARCH.—This is more extensively manufactured than any other potato product. All grades of potatoes have been found to yield starch of good quality. The author describes the methods employed in the American factories including the process of washing, grinding, sieving, settling and washing the starch, the treatment of "brown starch" (soft layer of sticky brownish sludge 2 to 6 inches in thickness, consisting of fine particles of cell-wall tissue from the potatoes and other impurities, and a certain quantity of starch), and finally, the drying and bagging. The average capacity of the starch factory with its dryer is four tons of dry starch per day.

As regards the value of potato starch compared with other starches, the author states that it is more valuable than maize and cassava starch, but somewhat inferior to wheat starch. The actual starch content amounts on an average to 15 per cent.

It has, however, value in the finishing and weaving of textiles which no other product possesses, especially fine grade cotton goods. It is also the source of the best grade of white dextrin used in making the finer grades of library paste.

Stem-Eelworm and Clover Susceptibility. *T. Goodey, Jour. Agr. Sci., Camb.*—The author endeavours to arrive at some notion of the different degrees of susceptibility shown by various clovers, and other leguminous plants of economic importance, to stem disease caused by the eelworm, *Tylenchus dipsaci.* The results show that all varieties of red clover are highly susceptible to attack, sharing in this respect with kidney vetch, alsike clover and cow-grass. These plants should, in infected districts, be replaced by less susceptible species, amongst which are included trefoil, lucerne, sainfoin, the seedlings of which were found to be very slightly attacked, and large white clover.

The Influence of Fertilisers upon the Productivity of the Soil. *W. H. Jordan, New York Agric. Expt. Stn., Bull.*— It was found, by growing barley under forcing-house conditions, on nine different types of soil consisting for the greater part of loams, that the vegetative growth was influenced very little by the application of either litter or leaf-mould. During the first year's experiments, well-composted farm manure did not produce additional growth, although the results obtained with it the second year were satisfactory, but the plants to which commercial fertilisers were applied grew much more than those receiving stable manure, the quantities of nitrogen, phosphoric acid and potash being the same in the two cases. Slaked lime applied with farm manure had a very irregular effect according to the different types of soil, in short, nitrogen appeared to be the sole fertilising substance having a marked influence upon barley.

To confirm these results, two soils were selected, one highly productive, and the other less fertile, and barley again planted. It was found that, under forcing-house conditions, the soils appeared to supply sufficient quantities of phosphorus and potassium for luxuriant vegetation.

The application to the soil of soluble compounds of nitrogen, phosphorus and potassium, materially increased the proportion of water solubles in the soil; these were used by the plants, and their amount was thus rapidly reduced before the barley had attained considerable growth. In the latter stages of its development, the quantity of the water-solubles remained constant and was much the same (with the exception of the phosphorus) as that present in the soil receiving no fertiliser.

To sum up; it would seem that from the practical standpoint, the above data show the importance of the solubility of the three essential ingredients of fertilisers, especially in the production of quickly-growing crops. Plants accumulate a large proportion of the required nitrogen and ash ingredients during the early stages of growth, for which reason, in the case of forcing-house culture, vegetable-gardening, and of such crops as cabbages, potatoes and wheat, an adequate supply of immediately available food appears to be indispensable in order to obtain good results.

Factors Influencing the Assimilation of Fertilising Matter by the Plant. *M. Wrangel, Berlin.*—In a preceding work this author showed that different plants use the phosphoric acid of slightly soluble phosphates in very unequal quantity. To study this phenomenon, cultural experiments were undertaken and the assimilation of phosphoric acid by the plants relatively to a different reaction (alkaline, neutral, acid by inorganic and organic acidity) of the soil solution and of the soil itself was observed.

With this object, fertilisers were used in mixture which had a neutral reaction; but if care was taken to supply equal quantities of fertilising foods, they were given in a different form and assorted so that a first group of tests remained neutral, the second became alkaline, the third acid had a citric acidity and the fourth acid a sulphuric acidity; moreover, a certain number of parallel tests were treated with calcium carbonate in quantity exceeding that necessary to neutralise the acidity which might eventually develop. The reaction of the soil, or rather of its solution, was controlled during the whole experiment and the effect of it on the assimilability of phosphoric acid, tricalcium phosphate, dicalcium phosphate and natural phosphate was studied first in a preliminary series of experiments with maize, then in a second with mustard.

The results obtained showed that the maize used only the slightly soluble phosphates when there was an acid reaction due to complementary manuring that was physiologically acid; the addition of lime caused the effect of the acidity to cease completely and consequently also the assimilation of phosphates. Mustard, however, could assimilate phosphoric acid from the slightly-soluble phosphates, even in the presence of a rather alkaline reaction, and this took place also independently of liming and even to some extent of the alkaline or acid reaction except when the intensity of the reaction was such as to give rise to effects that were toxic or harmful in some other way.

These statements seem to throw light on several phenomena, such as:—The contradictory results of liming; the exhaustion of the soil and rotations; the sensitiveness of certain plants to lime in spite of a relatively high requirement of lime; the formation of colloids in the circuit of the root system owing to the alternation of the acid and alkaline reaction.

The Importance of Magnesium Sulphate as a Fertiliser. *A. Jacob, Chemiker Zeitung.*—The problem of the fertilising action of magnesium sulphate is one of the chief questions confronting the agricultural chemist. It is, indeed, well-known that "Patent kali," the double sulphate of potassium and magnesium has long enjoyed high favour among Dutch agriculturists, especially as a fertiliser for potatoes and leguminosae, but it is probable that its reputation is due less to the absence of chloride (the fertiliser in question being preferred to potassium sulphate which also contains no chlorine), than to the stimulating effect of the magnesium.

The data relating to the question are very scanty, if we exclude Lōw's researches and discussions on the part played by calcium, and Willstaetter's discovery that chlorophyll is an organic magnesium compound containing 30 per cent. magnesium.

Since 1917, however, the German Potash Syndicate has been using magnesium in a vast series of manurial experiments carried out in Germany and Holland upon potatoes growing in different soils, the basal fertiliser consisting of 90 kg. nitrogen, 60 kg. phosphoric acid and 200 quintals of potassium.

The magnesium fertiliser was applied in the form of 2·5 quintals of kieserite (monohydrated sulphate of magnesium) that is to say, in amount corresponding to the magnesium in an equivalent dose of sulphate of potassium and of magnesium. A comparison was made between nitrogen, phosphoric acid and potassium chloride on the one hand, and nitrogen, phosphoric acid, potassium chloride and magnesium sulphate on the other; as well as between nitrogen, phosphoric acid and potassium sulphate on the one hand, and nitrogen, phosphoric acid, potassium sulphate and magnesium sulphate on the other.

Thirteen times in the thirty-nine experiments, the best crop of tubers was produced by plots fertilised with potassium chloride and kieserite, and eleven times by plots fertilised with sulphate of potassium and of magnesium.

The general averages of the yield were as follows:—Without potassium, 202 quintals per hectare; with chloride of potassium, 244 quintals; with sulphate of potassium, 250 quintals; with chloride of potassium and kieserite, 253 quintals; with sulphate of potassium and of magnesium, 253 quintals. In short, with the same amount of potassium, the addition of kieserite increased the crop, on an average 5·2 quintals per hectare. This occurred so frequently, that it may be attributed in some way to the presence of the magnesium.

The starch content was also affected; thus, the average starch production per hectare calculated for 1917-1919 was: Without potassium, 37·1 quintals; with potassium chloride, 40·1 quintals; with potassium sulphate, 44·2 quintals; with potassium chloride and kieserite, 41·5 quintals; with sulphate of potassium and of magnesium, 44 quintals. Apart from the manifest superiority of the sulphate, it is noticeable that in 1917 and 1918 the favourable effect of the magnesium was more marked.

It is not suggested that these experiments have succeeded in solving the magnesium question, which from the industrial and agricultural standpoints still remains open. It can, however, be said that, under certain given conditions, the use of magnesium fertilisers may considerably improve the yield.

Experiments made in the United States on the Value of Cottonseed Meal as a Partial Substitute for Grain in a Ration for Horses. *G. A. Bell and J. O. Williams, U.S. Dept. Agric., Bull.*—The objects of the experiment were to determine the value of cottonseed meal as a partial substitute for grain in a ration and also to determine the amount of cottonseed meal which can be fed with safety to work horses.

Sixteen horses (four pure-bred Morgans and twelve pure-bred and grade Percherons) were used and seven were used for control purposes. One mare died from an attack of pneumonia. All the horses were in splendid condition at the beginning of the experiment except one. Owing to the apparent dislike to the taste and odour of cottonseed meal it was mixed with wheat bran.

Only fresh, finely ground cottonseed meal was used and whole oats was used as the principal grain ration; the roughage fed was good quality timothy hay used *ad lib.*

The rations varied with the appetites of the animals. At the beginning of the experiment (October 1, 1917), the daily rations were as follows:—Oats, 8 to 27 lb.; timothy hay, 12 to 20 lb.; wheat bran, 3 lb.; cottonseed meal, 0·5 lb. For horses who ate satisfactorily or showed no signs of illness, the cottonseed meal was increased gradually from 0·5 lb. to 0·75 lb., 1 lb., 1·25 lb., 1·60 lb., 1·75 lb. and 2 lb., and in two cases up to 3 lb.

Mares fed on cottonseed meal during the period of pregnancy did not show any ill effects nor did the colts when foaled.

Twenty-three rations are suggested, the amount of cottonseed never in any case exceeding 1 lb. per 1000 lb. horse. Although some animals will consume more it is not advisable to exceed this limit. The mares in this experiment throve better and consumed their ration containing cottonseed meal more satisfactorily after they were turned out on pasture.

In any case, horses should be taught to eat cottonseed meal by giving them a very small quantity at first (about 0·25 lb. per day), and increasing it slowly so that they gradually become accustomed to the taste and odour of the meal.

Ox-Warbles in France and Switzerland.—Various papers have appeared in Continental journals dealing with the damage caused by ox-warbles, and the methods best suited for reducing the pest. In Switzerland the pasture regions are much affected and the annual loss is reckoned at over £40,000. In France the depreciation in the value of hides is estimated at about £1 a head, which gives an enormous total loss each year. In Switzerland the well-known methods of squeezing out the warbles from beneath the skin, or of destroying them under the skin are recommended; but in addition to these methods the French writer Huguier, suggests that the animals should be protected from the warble-flies by nets, ear-cloths and such like, and that bundles of vegetation, small branches of trees or bracken, should be hung in byres and stables and burned whenever numbers of the flies have taken shelter in them.

Danger of Extracting Ox-Warbles. *S. Hadwen, Jour. Amer. Vet. Med. Assn., Washington.*—Perhaps the commonest method of dealing with ox-warbles is the comparatively simple one of squeezing the larvæ out of the swellings they inhabit on the backs of cattle, before they have reached full larval development. This method has been used with excellent results, apparent in the reduced numbers of the subsequent brood of adult warble-flies; but there are dangers to stock which may arise through careless handling of the warbles, and to which attention ought to be drawn. The larvæ themselves contain toxic secretions and further, the cavities in which they lie often contain bacteria and streptococci. Should it happen, therefore, that rough handling bursts the warble before extraction, and causes any scratching on the walls of the cavity in the ox's back, there is great likelihood of a mixed infection, which may give rise to a general toxic condition. The disease known in Denmark as "rose fever" is probably due to some such warble poisoning. The author suggests that the skin of the ox should be softened with water to allow of the easier extraction of the warble by squeezing or by means of a forceps, and that should a warble burst in the process, the cavity should be at once flushed with clean water, which indeed is recommended to be used in rinsing the cavity after each extraction.

The Occurrence of Warbles in Man. *David M. Grieg, Edinburgh Medical Journal.*—Fortunately it is seldom that warble-flies deposit their eggs on human beings, or, if they do, that the larvæ enter the human system and do damage there. But cases, nevertheless, crop up in which larvæ have carried out migrations under the skin similar to those they perform in infected domestic stock. The author shows that, although the discovery of this fact has been attributed to workers in Vienna in 1895, the first case was described seventy-seven years before, by a Scotsman, Dr Spence of Lerwick. In the human subject the egg may be laid on clothing, such as stockings, and the larva, after hatching, makes its way to the skin, which it perforates. Underneath the skin it moves upwards until it may reach even the neck, forming during its progress an evident subcutaneous tunnel. Fortunately, the cause of the disturbance in man is generally recognised in good time, so that the larva is extracted while still in the second stage and small in size. No serious results have arisen from any known case of the presence of warbles in man, but it is a curious fact that females, whether children or adults, have been more often affected than males.

Cattle Poisoned by Horsetails (*Equisetum palustre*). *P. Hoc*, *Jour. d'Agric. Pratique.*—Although the horsetail (*Equisetum palustre*) is not regarded as a noxious plant, it is nevertheless poisonous to most animals. The author mentions some cases of poisoning in cattle, in the Department of Aisne, which were studied by M. Rohr, army veterinary-surgeon, in conjunction with the veterinary surgeon treating the animals. The animals had been given per head for three weeks, a supplementary ration of 3 kg. of hay, of which over one-third was composed of horsetails. Out of seventeen head, five died in a few days, the others were sold to the butcher.

The symptoms of poisoning are as follows:—Dejection, the animal not raising its head; difficulty in mastication; cessation of rumination; the eyes become hollow and the sight dim; the pulse and respiration are slow, the temperature falls. The fæces are black and have a strong odour. The sick beast soon leans its chest against the feeding-trough holding its head vertically, and its nose applied to the bottom.

The next day the animal is in a state of collapse, the eye sinks further into the socket, and complete loss of sight ensues.

Then follows a period of intense excitement, which might be taken for an actual fit of madness, but usually the animal rests its nose on the bottom of the trough, or on the ground, and pushes against the wall; the circulation quickens, respiration becomes difficult and loud, and asphyxia sets in. Then the affected animal falls down and dies, or sometimes rises once more, until it is carried off by another similar fit.

If the cattle have reached the stage of over excitement the meat has a febrific aspect, but if they are slaughtered at the beginning of the illness, before they have begun pushing at the wall, the flesh has a good appearance and can be eaten without risk.

Hyposulphite of soda, given before the disease manifested itself, seems to have reduced the number of cattle affected. It acts in the digestive tract as an anti-ferment. When once the illness has declared itself, no treatment is of any avail as the symptoms immediately become serious.

The degree of the toxicity of horsetails is very variable, depending entirely on the soil in which they grow, the way in which the fodder is kept and also upon the susceptibility of the animals, susceptibility being greatest when the cattle are young.

This explains why, in some cases, these plants have been eaten by stock with impunity. Equisetaceae are less dangerous when mixed with other foods, when they have been stacked for over six months or have been well washed by rain.

The toxic effect is due to an alkaloid or some other vegetable poison present in the horsetails. A subcutaneous injection made with 20 cc. of an infusion of the suspected hay, which had been concentrated at a low temperature to a tenth of its original volume, produced all the symptoms of acute poisoning in a guinea-pig or rabbit.

The Meat of Tuberculous Cattle from the Hygienic Standpoint. *G. C. Sparaponi*, *Annali d'Igiene*, *Rome.*—The problem of the use of meat from tuberculous cattle in the ordinary way for human food has been much discussed and studied during the last fifty years, but the results obtained have been contradictory and differently interpreted. This is due to the fact that, owing to the lack of accurate methods for determining the presence of latent tubercle bacilli in the meat or organs of the tuberculous cattle, there are no data upon which a correct judgment can be based. The author points out that the different results obtained by modern investigators as well as those of former times are attributable to the different anatomical types studied by them.

At the present day the anatomical forms of tuberculosis which make the meat toxic are well-known, but such meat when cooked, becomes innocuous, and according to Nocard and Leclainche, "the consumption of meat which is even raw, or but little cooked, and contains some tubercle bacilli has certainly no bad effect upon man." Further, there is no fear of toxic tubercular substances remaining in the cooked meat, since, as Galtier and Edelmann have shown, tuberculous beef contains only negligible quantities of such substances and these are very rapidly eliminated by the organisms of living cattle; this has been demonstrated by Fiorentini and Garino, who thus explain the fact that even serious tubercular lesions may exist where the state of nutrition of the affected animals is excellent.

Rumpel and many other authors have shown that the nutritive value of sterilised meat of tuberculous cattle is in no wise inferior to that of the flesh of healthy animals, so that the meat may safely be used for human food, for which purpose it is now very frequently sold in secret.

Pasteurisation of Milk in Bottles and Jars. *H. Kufferath, Annales de Gembloux, Brussels.*—In the course of tests carried out at the Intercommunal Laboratory at Brussels for the purpose of controlling the milk supplied by the Intercommunal Dairies, it was found to be quite impossible to pasteurise milk completely with the usual type of continual pasteurisers (the "holding process") under normal industrial conditions, and further that from the hygienic standpoint, the results obtained were disastrous. Thus, from 1915 to 1918, twenty-two samples out of twenty-nine examined were declared to be bad, and not to answer to the description of pasteurised milk; only four samples were good, and three were fair. On an average these milks contained 349,379 bacteria per cc., and in ten cases (or 34·4 per cent.) coli bacilli were discovered. Until the end of 1919, out of seven samples of pasteurised milk one would be found satisfactory and six unsatisfactory; four times coli bacilli were present, and the average number of micro-organisms was 910,693.

On testing the milk on the market, this was also proved to be insufficiently pasteurised.

Subsequently, the author, together with M. Bock, carried out some pasteurisation experiments at the Boitsfort dairy. They used simplified apparatus consisting of a steam generator, and a small metal boiler heated over an open fire; the steam was conducted by a tube to the pasteurisers, properly so-called, which were placed in another room. These consisted of simple vessels of galvanised iron with an internal diameter of about 1 metre, and a depth of 70 cm., having at the bottom an opening for the admission of the steam, and also a waste-pipe. The experimental data that follow refer to the heating of milk in bottles and jars.

It was found that in order for the pasteurising process to be carried out satisfactorily, heating, when bottles are used, must be continued from one and a half to one and three-quarters hours, counting from the first admission of the steam to the end of pasteurisation. With jars, fifty to sixty minutes is reckoned to be sufficient. The nineteen samples examined all proved satisfactory, the average number of micro-organisms being 472 per cc. In no case were coli bacilli present; the only micro-organisms discovered being spore-forming bacteria.

Experiments made in the United States on the Respective Values of Green Feeds as a Preventive of Intestinal Disorders of Growing Chickens. *A. G. Philips, R. H. Carr and D. C. Kennard, Jour. of Agric. Research, Washington.*—Report on experiments carried out in 1919 at Purdue University Agricultural Experiment Station, with a view to finding some appropriate means of checking intestinal putrefaction, the principal cause of mortality of chickens raised in confinement. It was decided to try a series of different compounds which might be expected to have an antiseptic effect or might serve to prevent constipation.

The stock used was 160 White Leghorn day-old chickens which were divided into ten lots of sixteen chickens each.

During the first four days, the chickens in all lots were given water and maize. Each bird was marked, and the weight was recorded.

Each lot was then given its respective ration. The basal ration given to all lots consisted of 50 parts cracked maize, 35 parts maize meal, 15 parts maize bran, 3 parts ash, 8·86 parts meat scrap, and 10·9 parts soybean meal (all parts by weight). To this basal ration one of several substances was added.

The addition of copper sulphate appeared to have the most beneficial and antiseptic effect as regards a preventive of intestinal putrefaction and consequent mortality. As to the use of sprouted oats, thought by some to be effective in lessening mortality, especially when fed for a short time only and when given as a supplement to a somewhat monotonous ration, in the present experiments no directly beneficial effect was evidenced.

The sulphur caused a continued looseness of the bowels; however, up to eight weeks of age this was one of the best lots.

The retarding effect of tobacco was pronounced, and resulted in stunting the growth during the first eight weeks. There was a tendency, however, for the chickens to recover somewhat by the age of fourteen weeks, but they always seemed more wild and nervous than those of any of the other lots.

The use of hydrochloric acid in the drinking water seemed to be of some benefit, seeing that the mortality was somewhat less than the average and the growth was consistent throughout the experiment.

Strawboard pulp, supplied to the ration for the purpose of adding bulk and thereby lessening the danger of impaction of the small intestine and cæcum, common when feeding a grain ration, did not seem to aid in reducing mortality.

The lots given a litter of oat straw to encourage the chickens to exercise, did not prove successful as regards growth nor was the mortality lessened. This ration has proved its efficacy in promoting growth, but has also proved its inefficiency in checking mortality, especially during the eighth and fourteenth weeks.

The experiments have shown that hydrochloric acid, sulphur and particularly copper sulphate, offer interesting possibilities in raising chickens in confinement.

The Gapeworm of Poultry spread by Turkeys. *B. H. Ransom, Bull.* 939, *U.S. Dept. Agric.*—Hitherto the occurrence of gapeworms (*Syngamus trachealis*) in poultry has in no wise been specially associated with the presence of turkeys, but general and experimental observations made by the Bureau of Animal Industry in U.S.A. suggest that a close connection may exist between turkeys and the presence and spread of gapeworms. There seems to be a possibility that the turkey was the original host of the gapeworm; for while adult fowls are little liable to attack, the turkey at all stages may be heavily infested, even although the infestation produces no visible signs of disease. It has further been noted that on farms where turkeys frequent the poultry runs, "gapes" is more common amongst the fowls; and also that on the removal of turkeys gapes shows a tendency to disappear from the poultry. On these and on experimental grounds it is suggested that to the turkey may be largely due the spread of gapeworms, and as a result the author suggests that the simplest method of preventing or reducing the losses caused by gapes is the exclusion of turkeys from farms where poultry is raised. But since infection may also be gained from ground already inhabited by infected poultry, because the eggs are passed in excreta, it is desirable that poultry should be excluded from such contaminated ground for a period of a year. The author adds that since adult fowls are much less susceptible to infection than chickens, probably brood hens may be associated with young chickens without running much risk of contracting the disease.

Method of Distinguishing an Egg Preserved in Lime Water from an Ordinary Egg. *K. Keis and J. Studinger, Annales des Falsification et des Frauds, Paris.*—According to the "Manuel Suisse des denrées alimentaires," the most certain way of distinguishing an egg which has been kept in lime-water from a fresh egg, is by determining the lime content of the ash of the albumen. The data given by the "Manuel Suisse" are based in Ivan Rözsenyi's work entitled "On eggs preserved in lime" (*Sur les œufs à la chaux*). The authors subject this book to a critical examination, and also give the results of their own experiments.

These tests show that the amount of lime present in the albumen of fresh eggs is very variable, about 0·59 to 4·25 per cent. of the ash. The lime content does not perceptibly increase, even if the egg is left for several months in lime water, and the weight of the egg remains unchanged. Therefore, the amount of lime in the white of an egg affords no means of judging whether or not the egg has been put in lime water.

The vitelline membrane of lime-preserved eggs is easily affected, after even a relatively short time. For this reason, the authors are of opinion that, as the lime content of the yolk is much higher than that of the white, the high figures obtained by Rözsenyi are due to a little yolk having been mixed with the white, owing to the rupture of the vitelline membrane when the egg was broken.

If this membrane is fragile, an egg can be considered as not fresh. It is well-known that the specific gravity of an egg that has been kept in the air shows whether it is fresh or not. In the case of eggs with an easily ruptured vitelline membrane, the specific gravity will not indicate whether they have been preserved in lime, but will show whether they have been preserved in some liquid, or kept in the air, the specific gravity in the latter case being much lower than in the former: the specific gravity of eggs preserved in a liquid remains invariable.

Bee Diseases in U.S.A. *E. F. Phillips, U.S. Dept. Agr. Circular*,—Investigations in the United States have reached the conclusion at which bee-keepers have arrived in this country, that the bee parasite *Nosema apis*, while it may give rise to diseased conditions, cannot be regarded as a serious or widespread cause of disease, in spite of the wide distribution of the parasite itself in bees in America. Close and continuous examination of bees has failed to reveal the presence in the United States of the bee-mite, *Acarapis woodi*, which Dr Rennie and his colleagues have identified as the cause of the so-called Isle of Wight disease in Great Britain. As a result the question of the prevention of the introduction of the mite into America has become one demanding immediate attention, and the author suggests that at once steps should be taken to place in quarantine bees imported from Britain and from the Continent of Europe generally, or to prohibit importation altogether. Of the two measures he strongly favours the latter, both on the score of the great saving in labour and money, and on the score of the effectiveness of a total prohibition policy.

OFFICIAL ORDERS AND CIRCULARS.

By the courtesy of the Scottish Board of Health, the Board are permitted to print the following circular which was issued by that Department during September to Local Authorities and Medical Officers of Health:—

Milk and Dairies (Amendment) Act, 1922.

Sale of Milk.

SIR,—The Scottish Board of Health desire to direct the attention of Local Authorities to the provisions of the above Act, which came into operation on 1st instant, and which applies to Scotland as well as to England and Wales.

The Act itself should be referred to for the specific enactments, but the following is a general summary of its main provisions:—

Local Authority under the Act.—The Local Authority for the purposes of the Act is the Local Authority under the Public Health (Scotland) Act, 1897, and the expenses of enforcing the Act is to be defrayed out of the Public Health General Assessment (Section 14).

Postponement and Repeal of Previous Acts.—The Milk and Dairies (Scotland) Act, 1914, is not to come into operation before 1st September 1925, and the actual date when that Act is to come into operation is to be fixed by Order of the Board.

The Milk and Dairies Acts (Postponement) Act, 1915, so far as it applies to Scotland, is repealed (Section 14).

Registration.—Important changes have been made in the system of registration of purveyors of milk. The system laid down in Section 6 of the Dairies, Cow-Sheds and Milk-Shops Order of 1885 remains, but the Local Authority are now required to keep two registers of milk vendors. One of these is to be a register of "persons carrying on the trade of retail purveyors of milk"; the other is to be a register of wholesale dealers and of producers who do not sell their milk by retail.

It is especially to be noted, however, that the following provisions *in regard to registration* apply only to retail purveyors.

In terms of the Order of 1885 the Local Authority were not empowered to refuse registration, or to remove any person from the register. They are now able, if satisfied that the public health is endangered, or is likely to be endangered, by any act or default of a retail purveyor, in relation to the quality, storage or distribution of milk, to refuse registration, or to take steps to remove him from the register. The procedure laid down is as follows:—

The Local Authority are to serve on the retailer a notice to appear before them not less than seven days after the date of the notice, to show cause why he should not be removed from the register, or why registration should not be refused. This notice is to specify the grounds on which the Local Authority propose either to refuse registration, or to remove him from the register, and it is to show whether the proposed refusal to register or to remove from the register is in respect of any specified premises or is absolute. If the retailer fails to show cause to the satisfaction of the Local Authority, they may refuse to register him, or may remove him from the register. Any person aggrieved by the decision of the Local Authority may, within twenty-one days, appeal to the Sheriff, and the Sheriff may require the Local Authority to register the retailer, or not to remove him from the register. Any decision by a Sheriff-Substitute may be appealed to the Sheriff if notice of appeal is given within seven days of the Substitute's decision. Removal from the register is not to take effect pending appeal to the Court. Where an appeal is made from a refusal to register, the retail purveyor is entitled to carry on business until the appeal is finally determined (Sections 2 (1) and 14).

When a retail purveyor is convicted of an offence under the Act or under the Dairies, Cow-Sheds and Milk-Shops Orders, the Sheriff may, on the application of the Local Authority, and in addition to any other penalty, order the removal from the register of the person so convicted, either absolutely or in respect of any premises, for such period as he may think fit (Section 2 (2)).

The distinction between absolute removal from the register, and removal as far as certain premises are concerned, is no doubt made to distinguish those cases in which the methods of a business are altogether unsatisfactory from those in which certain premises only are unsuitable, or the methods practised at those premises are objectionable.

Licences to Sell Milk under Special Designations.—In accordance with Orders which were issued under the Ministry of Food (Continuance) Act, 1920, and which remain in force till 1st January, provision has already been made for the issue of licences by the Scottish Board of Health for the sale of two grades of milk, namely, "Grade A (Certified) Milk," and "Grade A Milk." The Act now makes permanent provision for the sale of at least four grades of milk, namely, "Certified," "Grade A (Tuberculin Tested)," "Grade A" and "Pasteurised," and it is made an offence to sell milk under these designations without a licence. Provision is made for the issue of an Order by the Board authorising Local Authorities to issue such licences for certain grades. The conditions governing the use of these designations will be laid down in a further Order of the Board, and will include conditions as to the payment of fees (Sections 3 and 14).

It is to be noted that there is no prohibition of the pasteurisation of milk, nor is any general control of pasteurising plant contemplated. It is only in those cases where milk is described or referred to as "pasteurised" that the process must be in accordance with the provisions of the Order which is to be issued.

Prohibition of the addition of Colouring Matter, etc., to Milk.—In terms of the Act it is an offence to add any colouring matter, or water, or any dried or condensed milk, or any fluid reconstituted thereform, or skimmed or separated milk, to milk intended for sale. It is also an offence for any person to sell, *as milk*, any liquid in the making of which dried or condensed milk has been used. In county districts it will no doubt be the County Sampling Officer who will make investigations in connection with this matter, but proceedings must be undertaken by the Public Health Local Authority (Sections 4 and 14).

Prohibition of the Sale of Tuberculous Milk.—An important provision in Section 5 prohibits the sale of milk from a cow suffering from tuberculosis of the udder. Any person is guilty of an offence if it is proved that he sold milk from a cow suffering from tuberculosis of the udder, and that he knew, or could by the exercise of ordinary care have ascertained, that the cow was suffering from that disease. The fine for a first offence is not to exceed £20, and for a second or subsequent offence is not to exceed £100, or imprisonment, with or without hard labour, for a period of six months, or both such fine and imprisonment.

In the Dairies, Cow-Sheds and Milk-Shops Orders, and in the Burgh Police (Scotland) Act, 1903, proposals have already been incorporated with the object of preventing the sale of milk from cows suffering from tuberculosis of the udder, and, in view of the more stringent penalties in the new Act, the Board direct attention to the importance of enforcing this provision. Accordingly, the Local Authority should obtain the advice of the Medical Officer of Health in regard to the best means of enforcing the section, and should take systematic measures to ensure that no milk is sold in their area from cows suffering from tuberculosis of the udder.

Regulations by the Board.—The Board are empowered by Section 8 of the Act to make regulations for the prevention of danger arising to public health from the importation of milk intended for sale. They are also empowered to make regulations prescribing standards for dried and condensed milk, and for the labelling or marking of receptacles or tins, etc., of dried, condensed, skimmed or separated milk.

Penalties.—The penalties for contravention of the provisions of the Act are:—£5 for a first offence, and in the case of a second or subsequent offence £50, and a further fine of £2 for each day during which the offence continues. The penalty for selling the milk of a cow with a tuberculous udder has already been referred to, and I am to remind Local Authorities of the power they possess under the new Act to apply to the Sheriff for the removal from the register of any person convicted of an offence under the Act or under the Dairies Orders (Sections 2, 5 and 9).

I have to request you to submit this communication to the next meeting of the Local Authority. Further copies may be obtained from H.M. Stationery Office, 23 Forth Street, Edinburgh, price 1½d., post free. A copy has been sent direct to the Medical Officer of Health.—I am, Sir, your obedient Servant,

JOHN JEFFREY, *Secretary.*

The following notice was issued by the Board of Agriculture for Scotland to the press during August:—

Seeds Act, 1920. Amended Seeds Regulations.

Seeds Regulations.

The Board of Agriculture for Scotland announce that the Seeds (Scotland) Regulations, 1921, which were made by them in pursuance of the provisions of Seeds Act, and which have been in force since 1st August 1921, will be withdrawn as from 10th August 1922, and substituted by the Seeds (Scotland) Regulations, 1922.

In the new Regulations certain minor amendments have been made in the terms of the original Regulations. The effect of these amendments is as follows:—

(1) Grass and clover seeds when sold or exposed for sale for other than agricultural purposes (*e.g.*, lawn grass) will be excluded from the operation of the Seeds Act;

(2) A statement of the percentage of pure germinating seed in grasses and clovers will no longer be required ;

(3) Alsike and white clover when grown together may be treated as one seed, provided they are declared to have been grown together ;

(4) Sprouted seeds will not be treated as an impurity in the testing of cereal seeds ;

(5) The authorised minimum percentage of germination of broccoli and cauliflower will be reduced from 65 to 60 per cent. ;

(6) Potatoes which are less than 97 per cent. in purity may be sold for seed purposes, provided they are described as being of mixed varieties.

Copies of the Seeds (Scotland) Regulations, 1922, may be obtained through any bookseller, or directly from H.M. Stationery Office, 23 Forth Street, Edinburgh, price 3d. each.

The following press notices have recently been issued by the Board :—

Wart Disease of Potatoes.

Potatoes.

The Board af Agriculture for Scotland desire to remind all farmers, allotment holders and other growers of potatoes, and also all potato merchants and dealers, that wart disease of potatoes is scheduled under the Destructive Insects and Pests Acts, 1877 and 1907, as a notifiable disease. Accordingly, the occupier or other person in charge of any land in which the disease exists or appears to exist, and any person having in his possession or under his charge any potatoes which are affected with the disease is required to report the fact without delay to the Local Authority or to the Board of Agriculture for Scotland, York Buildings. Queen Street, Edinburgh. Notification must also be given of any recurrence of the disease in land known to be infected. Failure to report the existence of wart disease renders the person concerned liable on conviction to a penalty of £10.

In the interests of the Scottish potato trade it is of the utmost importance that prompt notification be given of any outbreak of the disease, in order that immediate steps may be taken to prevent its further spread. Growers should, accordingly, examine their crops carefully, particularly at lifting, with a view to detecting any evidence of the existence of the disease. Where crops of the immune varieties are grown, it should be remembered that while these varieties are resistant to attack by wart disease, evidence of the presence of the disease is sometimes found in such cases on "rogue" plants or "ground keepers" of susceptible varieties.

In the earlier stages of the disease small swellings bearing a distinct resemblance to warts, appear in the eyes of affected tubers. In the later stages, or when the disease is severe, several warts run together and form an irregular spongy mass. The growth of the fungus is not always confined to the tuber, but is occasionally found at the base of the haulm. As a general rule the disease can easily be identified, and is readily distinguishable from any other potato disease, but it is advisible in all cases when reporting an outbreak of the disease to forward a specimen tuber affected with the disease for examination.

Export of Potatoes.

The Board of Agriculture for Scotland have been informed by the United States Department of Agriculture that the prohibition previously imposed on the admission of potatoes into the territories of Hawaii and Porto Rico has now been withdrawn. Potatoes from any foreign country may now, until otherwise ordered, be imported into these territories free of any restrictions whatsoever.

Agricultural Scholarships.

The Board recently issued the following circular detailing a scheme for providing, in the terms of the Corn Production Acts (Repeal) Act, 1921, Agricultural Scholarships for the Sons and Daughters of Agricultural Workmen and others.

1. The Board have approved a scheme for establishing Scholarships and Maintenance Grants for the sons and daughters of agricultural workmen and others. The scheme will be

administered by the Board, with the assistance of the Scottish Education Department, the Education Authorities, and representatives of the Agricultural Colleges, and Agricultural Labour Organisations in Scotland.

2. Benefits under the scheme are confined to the sons and daughters of agricultural workmen, or of other rural workers whose financial circumstances are comparable to those of agricultural workmen. All applicants must be British subjects, and resident in Scotland. They must intend to take up an agricultural or allied pursuit after receiving the training covered by the award.

3. The Board's scheme provides for four types of Scholarship, as follows:—

Class I. Not more than thirty short course allowances, not exceeding 35s. per week, for a period not exceeding ten weeks, which will enable the holders to attend short courses in agriculture of from four to ten weeks' duration. Applicants should be over sixteen years of age, and must have been engaged for at least a year in agriculture or other similar work.

Class II. Six Certificate Course Scholarships, each not exceeding £30 in value, which will enable the holders to attend courses of instruction in agriculture during one winter session, lasting about twenty weeks.

Applicants should be over seventeen years of age, and must have been engaged for at least a year in agriculture or other similar work.

Class III. Three Diploma Course Scholarships, each not exceeding £120 in value, which will enable the holders to attend the courses of instruction for diplomas awarded by Agricultural Colleges in Scotland. These courses as a rule require attendance at classes during three winter sessions of about twenty weeks each.

Applicants must have gained the Intermediate Certificate of the Scottish Education Department or reached a similar standard of education, and must be prepared to sit a preliminary examination, if required.

Class IV. Three Degree Course Scholarships, each not exceeding £360 in value or £120 in any one year, which will be tenable while students attend courses of instruction for the degree of B.Sc. (Agriculture) of a Scottish University during three academic years or thereby, or for the qualification of M.R.C.V.S. at the Edinburgh or Glasgow Veterinary Colleges.

Applicants must have passed an examination which qualifies them for entrance to a university.

In addition to the allowances described above, class fees will be paid in respect of all scholarships awarded. Travelling expenses may be paid either in addition to, or wholly or partly in place of, the allowances.

4. Particulars of the courses for which the four classes of Scholarships will be available may be had from the Secretaries of the Agricultural Colleges at Aberdeen, Edinburgh and Glasgow, and also (in the case of Class IV. Scholarships only) from the Secretary of the Royal (Dick) Veterinary College, Edinburgh, and the Secretary of the Veterinary College at Glasgow.

5. Applications for Scholarships should be made on forms supplied for the purpose, and should be forwarded, in the first instance, to the Education Authority for the area in which the applicant resides, not later than 30th September 1922.

6. Candidates should take particular care to complete the form accurately, and should see that all the information asked for is fully given. The application may be accompanied by testimonials from an employer, if the candidate has been in employment since leaving school, or from any other responsible person.

7. Payment of allowances to selected candidates will be contingent upon

the receipt of satisfactory reports on the student's progress, and upon the fulfilment of all the conditions attached to the Scholarships, details of which will be supplied to those to whom Scholarships have been awarded. Any further information may be obtained from the Secretary to the Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

The following preliminary announcement was made by the Board in the press regarding schemes of land drainage for the relief of unemployment during the coming winter:—

Drainage Work for the Unemployed.

The Board of Agriculture for Scotland announce that His Majesty's Government have now sanctioned the continuance in Scotland during the coming winter of the Land Drainage Scheme for the alleviation of unemployment.

The conditions upon which public money will be available (which will be substantially the same as last year) will be announced in the press as soon as possible.

No action involving expenditure by intending applicants should be taken until the further information is available.

The following press notice was issued by the Board in the end of July:

District Agricultural Committees.

Hitherto certain powers have been exercised by the District Agricultural Committees constituted by the Board of Agriculture for Scotland. Under the Agriculture Act the Committees were empowered:—

(1) To grant or refuse an application for a certificate that a tenant is not cultivating his holding according to the rules of good husbandry: and

(2) To grant or refuse an application by the tenant of a holding that whole or part of the holding is suitable for the purposes of a market garden, and that with regard to such area the special provisions of the Agricultural Holdings Act relative to compensation shall apply.

Under the *Increase of Rent and Mortgage Interest* (*Restrictions*) *Act*, *1920*, also, they had power to grant or refuse an application for a certificate that a dwelling-house is required for the occupation of a person engaged on work necessary for the proper working of an agricultural holding. These powers have now been transferred to the Board of Agriculture for Scotland in terms of an Order in Council made on 14th July. It will be necessary in future, therefore, for intending applicants to communicate direct with the Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in June, July and August, 1922.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	JUNE.			JULY.			AUGUST.		
	1st.	2nd	3rd.	1st.	2nd.	3rd.	1st	2nd	3rd.
FAT STOCK :-									
CATTLE--	per cwt. l.w. s. d.	per cwt. l.w s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus	82 11	75 2	53 10	83 4	76 2	50 3	80 9	72 1	48 8
Shorthorn	83 0	79 0	54 0	...	...	...	..	..	...
Galloway	76 3	68 6	...	74 1	68 11	...	70 11	63 10	...
Ayrshire	70 11	53 3	36 6	71 6	52 3	34 0	66 10	54 10	39 4
Cross-bred	79 8	71 9	50 11	79 1	71 8	49 2	75 6	67 4	45 7
Blue Grey	85 11	...	...	...	...	...	86 8	...	...
Highland	...	...	...	...	...		.	...	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES	16¾	9½	7½	16¼	9¼	7	13¼	7½	5½
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.
Cheviot	21¼	19½	16	19½	18	15	17½	16½	13½
Half-bred	21	19¾	14¼	19¼	18	13½	17½	16½	11½
Blackface	20¼	18	15¾	18¾	16¾	14¾	17¾	15¾	13¼
Greyface	20¾	19	14½	19¾	17¾	14	18	16¾	11¼
Down Crosses	21¼	20	..	19	18½	...	17½	16½	...
PIGS—	per stone. s. d.	per stone. s d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	14 2	12 3	10 11	14 7	12 8	11 0	14 11	13 2	11 3
Porkers	14 2	13 1	10 11	14 8	13 2	11 0	14 10	13 7	11 3

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	June.			July.			August.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
STORE STOCK:									
STORE CATTLE—									
	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.	per head. £ s.
Aberdeen-Angus:									
Yearlings ...	23 0	19 3	14 14	22 15	18 12	14 13	21 2	16 18	12 12
Two-year-olds ...	30 8	26 7	23 10	31 8	26 11	21 10	31 12	25 14	...
Shorthorn:									
Yearlings ...	...	...	...	..	...	...	...	...	...
Two-year-olds	...	...	...	...	...	...	...	...	...
Galloway:									
Yearlings	18 4	13 0	...	15 4	...	...	13 17	...	...
Two-year-olds ...	35 15	28 0	...	27 6	...	...	24 15	...	...
Ayrshire:									
Yearlings	12 10	9 18	...	10 6	8 10	..	..	...	...
Two-year-olds	16 15	11 5	...	19 0	15 0	..	...	...	...
Cross-bred:									
Yearlings ...	20 11	17 9	13 17	20 1	17 8	14 13	18 11	15 9	10 13
Two-year-olds ...	28 14	25 4	21 2	28 15	24 19	19 17	27 19	23 5	19 8
Blue Grey:									
Yearlings	...	..	...	...	...	...		...	...
Two-year-olds ..	...	...	.		...	...	...	...	..
Highland:									
Yearlings	11 10	9 14	7 17	9 8	7 15	6 11	9 0	7 10	6 0
Two-year-olds ...	17 15	14 5	12 12	13 9	11 9	10 0	11 10	10 10	...
Three-year-olds ...	28 13	23 15	20 10	18 18	16 3	12 5		...	...
DAIRY COWS—									
Ayrshire:									
In Milk	34 6	24 14	14 10	35 12	26 3	14 15	35 2	24 14	15 9
Calvers	36 6	25 9	16 11	35 16	25 11	17 0	35 1	24 4	16 6
Shorthorn Crosses:									
In Milk	41 18	31 8	22 15	41 9	30 5	23 0	41 1	29 15	22 9
Calvers	41 9	28 7	18 8	40 13	28 11	19 4	39 13	27 12	18 2
STORE SHEEP—									
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	52 10	44 6	36 3	53 0	46 11	38 4	58 9	46 6	29 6
Half-bred Hoggs ...	107 10	75 0	60 4	75 0	60 0	55 6	81 11	..	...
Blackface Hoggs ..	48 3	36 9	30 5	45 9	40 0	32 0	41 0	...	25 0
Greyface Hoggs .	67 0	53 8	44 5	67 3	52 9	44 0	62 9	40 0	36 0
STORE PIGS—									
(6 to 10 weeks old)	58 8	42 1	...	55 6	40 8	...	50 8	35 4	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters*)

Description.	Quality.	June.			July.			August.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF :–		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb *d.*	per lb. *d.*	per lb. *d*	per lb. *d.*	per lb. *d.*
Home-fed—										
Bullock or Heifer ..	1	13⅛	12½	14¼	12⅞	13⅛	13⅞	11¾	12⅜	13¼
	2	12¼	10¾	12	12⅛	10⅞	12⅞	11⅜	10¼	11⅝
Bull	1	9¾	10⅛	9¾	10¾	10⅞	10⅝	10	9⅞	9¾
	2	9	8⅞	8⅜	10⅛	9⅝	10	9¼	9	8¾
Cow	1	8¼	8¼	9¾	8⅜	9	10⅛	8	7¾	8½
	2	7¼	7	6¾	7¾	7⅝	9¼	7	7	6¾
Irish—										
Bullock or Heifer ..	1	...	...	12⅜	..	...	11¼	...		10¾
	2	...	...	10¼	...	...	10⅜	...	..	9¾
Bull	1	...	...	9	...	...	9⅝	...	..	9
	2	...	...	7	...	...	8¾	...	.	7¼
United States and Canadian										
Killed at Glasgow ...	1	..	...	12⅛	...	...	...	...	...	10½
	2	...	...	10⅝	.	...	...	...	...	9½
Argentine Frozen—										
Hind Quarters ...	1	...	5⅝	5⅝	...	5⅞	6⅛	...	6¼	6¼
Fore ,, ...	1	...	4¼	4⅛	..	4	3½	...	3⅞	3¾
Argentine Chilled—										
Hind Quarters ...	1	...	8	8¼		7⅛	7⅛	...	7½	7¼
	2	.	...	7⅜	..	..	6⅝	...	...	6¼
Fore ,, ..	1	.	4¼	4¼	.	4	3¾	...	4	4
	2	...	...	3¾	...		3¼	..	..	3¾
New Zealand Frozen—										
Hind Quarters ...	1	...	...	4½	.	..	4½	..	...	...
Fore ,, ..	1	...	...	3¾	...	...	3⅛	.	.	.
	2	..	...	3½	..	...	3	...	...	...
Australian Frozen—										
Hind Quarters ...	1	..	. .	...	...	...	4¾	..	..	5
Fore ,, ...	1	...	...	...	...	...	3	...	...	3¾
MUTTON :–										
Hoggs, Blackface ...	under 60 lb.	20½	19¼	20¾	19¼	16⅝	17⅜	18¼	15½	16¾
	60 lb. and over.	19½	18⅝	19¼	...	15¾	16½	..	15	15½
,, Cross .. .	under 60 lb.	20½	20⅛	20½	19¼	17¼	17¾	18¼	16⅛	16¾
	60 lb. and over.	19½	19⅛	19¼	...	16¼	16½	...	15¼	15½
Ewes, Cheviot ...	1	16¾	15½	15½	14½	13⅛	12⅞	12⅜	12⅜	12
	2	16	...	13½	...	...	11½	11	...	9⅞
,, Blackface ...	1	16¾	...	15¼	14½	..	12⅝	12⅜	...	11¾
	2	16	...	13	...	...	11½	11	...	9⅛
,, Cross	1	14¼	12¾	12¾	10½	11⅝	11¾	9⅜	11⅜	9⅞
	2	...	...	11¼	10	...	9½	8	...	8
Argentine Frozen ...	1	...	7⅞	7⅛	..	6⅝	5⅝	...	6¼	6
	2	...	7	6½	...	...	...	...	5½	5½
Australian ,, ...	1	..	...	6¾	...	...	5	...	5¾	6
LAMB :—										
Home-fed	1	21⅝	20¼	22⅜	20½	17⅝	18⅞	18¼	16½	16⅞
	2	...	19	20¼	...	...	17¾	...	16¼	15½
New Zealand Frozen	1	...	12⅝	12⅛	...	12½	12⅛	...	12½	11⅞
	2	...	...	11⅛	...	...	11½	...	...	11¼
Argentine ,, ...	1	...	10	...	..	10	10	...	9¾	10
	2	...	...	..	..	...	9¼	...	...	9¼
Australian ,, ..	1	...	...	11	...	...	...	...	...	...
	2	...	...	10	...	...	..	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	June.		July.		August.	
		s.	*d.*	*s.*	*d.*	*s.*	*d.*
BUTTER:							
Irish Creamery ... per cwt.	1	199	6	218	6	200	10
,, ,, (Unsalted) ,,	1	204	6	224	6	212	0
Canadian ... ... ,,	1	...		...		...	
,, (Unsalted) ,,	1	...		...		...	
Danish ... ... ,,	1	203	0	220	3	215	7
,, (Unsalted) ,,	1	156	0	229	6	222	10
Australian ... ... ,,	1	193	0	218	9	203	0
,, (Unsalted) ,,	1	175	0	...		...	
New Zealand ... ... ,,	1	199	6	223	0	209	7
,, (Unsalted) ,,	1	185	0	...		...	
Argentine ... ... ,,	1	171	0	...		...	
,, (Unsalted) ,,	1	175	0	...		...	
CHEESE:							
Cheddar ... ... ,,	1	83	0	94	0	90	5
	2	72	0	90	0	86	5
Cheddar Loaf ... ... ,,	1	101	0	110	6	106	0
Dunlop ... ... ,,	1	79	9	91	0	84	5
	2	77	3	87	6	81	2
Canadian ... ... ,,	1	90	6	96	0	92	0
	2	88	0	93	0	88	5
New Zealand ... ... ,,	1	93	6	97	6	93	2
	2	83	4	...		...	
New Zealand (White) ,,	1	105	0	98	0	94	2
	2	95	0	93	9	91	7
BACON:							
Ayrshire (Rolled) ... ,,	1	190	6	198	6	199	7
Irish (Green) ... ... ,,	1	174	6	168	6	167	7
,, (Dried or Smoked) ,,	1	190	0	189	0	194	10
,, (Long Clear) ... ,,	1	163	9	185	0	184	0
Wiltshire (Green) ... ,,	1	174	6	168	6	167	7
,, (Dried or Smoked) ,,	1	190	0	189	0	195	0
American, Long Clear Middles (Green) ,,	1	116	0	114	6	119	0
BACON (*continued*):							
American, Short Clear Backs ... ... per cwt.	1	90	0	90	0	93	0
American Bellies ... ,,	1	86	0	86	0	86	0
,, Sides ... ,,	1	106	0	112	0	118	0
	2	102	0	102	0	102	0
,, Cumberland Cut ,,	1	106	0	102	6	111	2
	2	100	0	98	6	106	0
Canadian, Sides ... ,,	1	135	0	136	6	138	2
Danish, Sides ... ,,	1	166	0	158	6	154	0
HAMS:							
Irish (Smoked) ... ,,	1	245	0	245	0	243	2
	2	240	0	240	0	238	10
American, Long Cut (Green) ... ... ,,	1	144	6	145	6	123	7
	2	138	0	...		...	
American Short Cut ,,	1	139	6	138	0	116	0
	2	136	0	135	6	113	7
Canadian, Long Cut ,,	1	...		...		...	
EGGS:							
Country ... ... per doz.	1	1	8	1	11	2	1
	2	1	6	1	9	1	11
Irish ... ... per 120	1	14	6	17	6	17	4
	2	13	8	16	7	16	2
,, (Duck) ... ,,	1	13	2	16	0	16	4
Danish ... ... ,,	1	16	3	18	8	18	4
	2	15	3	17	0	16	7
Polish ... ... ,,	1	10	6	11	11	11	10
Chinese ... ... ,,	1	13	3	12	9	12	2
	2	12	3	12	0	...	
Lithuanian ... ,,	1	13	6	14	4	12	2

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

MARKETS.	Quality.	First Earlies.	Late Varieties.			
			Red Soils.		Other Soils.	
			Langworthy.	Other.	Langworthy.	Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
		JUNE.				
Dundee	First ...	...	...	...	...	5 17 6
	Second ...	...	...	...	...	...
Edinburgh	First ...	18 0 0	...	...	...	7 11 8
	Second ...	...	...	...	...	...
Glasgow	First ...	22 0 0	...	12 0 0	...	5 0 0
	Second ...	...	...	...	...	...
		JULY.				
Dundee	First ...	8 6 8	...	...	...	...
	Second ...	...	...	...	...	...
Edinburgh	First ...	8 2 6	...	...	...	...
	Second ...	...	...	...	...	...
Glasgow	First ...	8 16 8	...	...	...	...
	Second ...	...	...	...	...	...
		AUGUST.				
Dundee	First ...	7 0 0	...	...	...	...
	Second ...	...	...	...	...	...
Edinburgh	First ...	4 11 3	...	...	...	...
	Second ...	...	...	...	...	...
Glasgow	First ...	3 6 3	...	...	...	...
	Second ...	...	...	...	...	...

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Markets.	Quality.	Roots.			Hay.		Straw.			Moss Litter.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Barley.	Oat.	
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.
		JUNE.								
Dundee ...	1	...	...	...	187 6*	...	90 0*	...	90 0*	..
	2	...	...	...	...	...	...	...	...	...
Edinburgh	1	...	...	...	198 9†	...	81 3†	...	86 3†	...
	2	...	...	...	180 0†	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	30 0
		JULY.								
Dundee ...	1	...	...	...	185 0*	...	95 0*	...	95 0*	...
	2	...	...	...	120 0*	...	...	...	...	...
Edinburgh	1	...	...	...	180 0†	...	85 8†	...	90 0†	...
	2	...	...	...	...	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	30 0
		AUGUST.								
Dundee ...	1	...	...	...	154 0*	...	100 0*	...	100 0*	...
	2	...	...	...	112 0*	...	...	...	...	...
Edinburgh	1	...	...	...	111 0†	...	92 0†	...	96 0†	...
	2	...	...	...	...	...	...	...	...	...
Glasgow ...	1	...	...	...	...	...	...	...	...	28 6

* Price for Hay and Straw baled and delivered.

† Price for Hay and Straw delivered loose in town.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	June.						July.						August.					
	Glasgow.			Leith.			Glasgow.			Leith.			Glasgow.			Leith.		
	per ton.			per ton			per ton.			per ton.			per ton.			per ton.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Linseed Cake—																		
Home	14	5	0	14	2	3	13	18	4	13	10	0	14	5	0	13	11	0
Foreign	13	15	0	...			...			...			13	15	0	...		
Undecorticated Cotton Cake –																		
Bombay (Home-manufactured)	...			7	2	6	...			7	6	3	7	15	0	7	7	6
Egyptian (Home-manufactured)	8	16	8	...			8	18	9	...			9	0	0	...		
Groundnut Cake	10	0	0	10	2	6	10	1	3	10	7	6	10	8	4	10	7	6
Palmnut Kernel Cake	...			...			...			...			...			...		
Bean Meal ...	13	10	0	13	10	0	13	2	6	13	10	0	13	0	0	13	10	0
Maize	*8	1	3	8	7	6	*8	10	8	8	11	3	*9	1	0	8	12	0
Maize Meal ...	9	1	3	9	10	0	9	7	6	9	11	3	9	9	0	9	12	0
Maize Gluten Feed (Paisley)	8	10	0	...			8	12	6	...			8	17	6	...		
Maize Germ Cake Meal	10	1	8	...			10	15	0	...			11	2	0	...		
Rice Meal... ...	8	0	0	...			8	0	0	...			8	1	3	...		
Locust Bean Meal	...			8	0	0	...			8	5	8	...			8	7	6
Maize Germ Cake	9	11	8	...			10	5	0	...			10	12	0	...		
Barley (Feeding) ...	10	6	3	10	0	0	10	7	6	10	0	0	10	0	0	...		
Oats, American ...	9	11	11	10	5	0	9	8	2	...			9	11	0	...		
„ Home ...	11	9	2	11	7	6	11	8	9	11	7	6	11	10	0	11	7	6
Malt Culms ...	5	10	0	...			5	10	0	...			5	10	0	...		
Distillery Malt Grains Dried...	7	18	9	...			8	5	0	...			8	7	6	...		
Distillery Mixed Grains—																		
Dried	...			8	12	6	9	0	0	8	10	0	9	0	0	8	10	0
Wet	...			1	15	0	...			1	15	0	...			1	15	0
Brewers' Grains –																		
Dried	...			8	0	0	...			8	0	0	...			8	0	0
Wet	...			1	15	0	...			1	15	0	...			1	15	0
Wheat –																		
Middlings (Fine Thirds or Parings)	8	7	6	8	12	6	9	10	0	9	3	9	10	3	0	10	0	0
Sharps (Common Thirds)	7	8	9	7	5	0	7	15	0	7	11	3	8	2	0	8	0	0
Bran (Medium) ...	7	5	0	7	4	5	7	10	0	7	3	9	7	7	0	7	5	0
„ (Broad) ...	7	10	0	...			...			...			...			...		
Feeding Treacle ...	5	15	0	6	15	0	5	15	0	5	15	0	5	15	0	5	15	0
Crushed Linseed ...	...			22	0	0	...			22	0	0	...			...		
Fish Meal... ...	14	10	0	15	10	0	15	7	6	15	0	0	15	0	0	15	0	0

* American corn.

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